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ABSTRACT

One of twelve individualized courses included in an automotive repair curriculum, this course covers the theory, maintenance, and repair of front-end suspension and steering mechanisms. The course is comprised of five units: (1) Tire Balancing, (2) Manual Steering Gears, (3) Power Steering, (4) Fundamentals of Suspension, and (5) Front-End Alignment. Each unit begins with a Unit Learning Experience Guide that gives directions for unit completion The remainder of the unit consists of Learning Activity Packages (LAP) that provide specific information for completion of a learning activity. Each LAP is comprised of the following parts: objective, evaluation procedure, resources, procedure, supplemental sheets, study guide, and a LAP test with answers. The course is preceded by a pretest which is designed to direct the student to units and performance activities. (LRA)

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MOUNTAIN PLAINS LEARNING EXPERIENCE GUIDE:

Automotive Repair.

Course: Suspension Systems.

CE027728

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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Mountain-Plains Education &
Economic Development
Program, Inc.

Glasgow AFB, Montana 59231

Learning Experience Guide

COURSE: SUSPENSION SYSTEMS

DESCRIPTION:

Suspension Systems covers the theory, maintenance, and repair of front-end suspension and steering mechanisms.

RATIONALE:

The theory and techniques covered in this course will enable you to analyze failures and repair suspension systems to manufacturer's specifications.

PREREQUISITES:

Math Skills level E or higher as determined by the specific requirement of the particular job title.
Communication Skills level E or higher as determined by the specific requirement of the particular job title.

OBJECTIVES:

Perform maintenance and repair of automotive suspension systems.

RESOURCES:

A course resource list is attached.

GENERAL INSTRUCTIONS:

This course has 5 units. Each unit has a Unit Learning Experience Guide (LEG) that gives directions for unit completion. Each unit consists of Learning Activity Packages (LAPs) that provide specific information for completion of a learning activity. Pretesting results direct the student to units and preformance activities.

The general procedure for this course is as follows:

1. Read the assigned unit LEG for this course.

Principal Author(s): C. Schramm/W. Osland

2. Begin and complete the first LAP.
   a. Take and score the LAP test.
   b. Turn in the LAP test answer sheet.
   c. Determine the reason for any missed items on the LAP test.
   d. Proceed to the next assigned LAP in the unit.
   e. Complete all required LAPs for the unit by following steps (a) through (d).
3. Take the unit tests as described in the Unit LEG "Evaluation Procedures".
4. Proceed to the next assigned unit in this course.
5. Follow steps 1 through 4 for all required units for this course
6. Proceed to the next assigned course.

You will work independently unless directed otherwise. When questions or problems arise, you are expected to discuss them with the instructor. At all times remember to follow correc safty procedures during the preformance activity.

UNIT TITLES:

.01 Tire Balancing
.02 Manual Steering Gears
.03 Power Steering
.04 Fundamentals of Suspension
.05 Front-End Alignment

EVALUATION PROCEDURE:

Course evaluation is by pre and post testing using a multiple-choice type of test.

In this course, the course test is used as a pretest to determine which units, if any, the student may be able to validate. The student is considered validated for a particular unit if 4 out of 5 items are correctly answered for each LAP part on the course pretest and that particular unit does not have a preformance test requirement.

For those units with preformance test requirements, the student must also satisfactorily complete the preformance test to validate that unit. Unit preformance tests validation procedures are given in the 'Evaluation Procedure" section of the unit Learning Experience Guide (LEG)

The course test will also be taken by the student as a post test to determine any changes resulting from taking all or part of the course. Score at least 80% correct on the post test.

FOLLOW-THROUGH:

Go to the first Unit Learning Experience Guide (LEG) listed on your Student Progress Record (SPR).

RESOURCE LIST

Printed Materials

1. Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc., 1969.
2. Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company Inc., 1969.
3. Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.
4. Parts and Labor Guide.

Audio/Visuals

Super 8 Sound Films: Wheel Balancing

DCA Educational Products, Inc.

1. Front Wheels (#FAA042).
2. Rear Wheels (#FAA052).
3. Run Out and Out of Balance (#FAA032).

Super 8 Sound Films: Wheel Alignment

DCA Educational Products, Inc.

4. Adjusting Torsion Bar Suspension (#FAA142).
5. Caster Camber Adjustment, Cam Assembly (#FAA102).
6. Caster Camber Adjustment, Shim (#FAA112).
7. Caster Camber Adjustment, Slide (#FAA122).
8. Checking Camber (#FAA072).
9. Checking Caster (#FAA082).
10. Checking Toe and Centering Steering (#FAA092).
11. Set Up and Suspension Checks (#FAA062).
12. Toe and Center Steering Adjustments (#FAA132).

Equipment

1. Automobiles needing: front-end alignment
   front-end repair
   manual steering service and repair
   power steering service and repair
   tire balancing
   wheel bearing service and replacement
2. Projector, AVT Systems Super 8 mm Instant Film Loop Player.

3. Replacement parts: ball joints
   - control arm bushings
   - cotter key
   - cotter pin
   - for gearbox
   - for power steering control unit
   - for power steering cylinder
   - for power steering pump
   - gasket set
   - idler arm
   - race
   - tie rods
   - weights
   - wheel bearings
4. Safety equipment: fender cover
   - gloves
   - goggles
   - jack stands
5. Supplies: bearing grease
   - chalk or scribe
   - gearbox lube
   - grease
   - power steering fluid
   - shop cloth
   - solvent
6. Tools, basic hand: chisel and punch set
   - 5/32" pin punch
   - 3/16" solid
   - gauge, feeler (.002" - .025")
   - hammer, ball peen
   - hammer, plastic tip
   - handle, speed
   - hex key set
   - pliers, diagonal cutting
   - pliers, needle nose
   - scraper, gasket
   - screwdriver, standard (set)
   - screwdriver, Phillips (set)
   - screw starter
   - socket set (3/8" drive)
     - extension (3")
     - ratchet
   - socket set (1/4" drive)
     - extension (3")
     - handle (6" flex)
     - ratchet
   - socket, spark plug
     - extension (6")
   - wrench, combination (set)
   - wrench, combination ignition (set)
7. Tools, general: chisel, air
   - creeper
   - drain pan
   - gauge, tire pressure
   - hoses
   - jacks or lift
   - vise, bench
   - wrench, lug

8. Tools, suspension system:
    - alignment equipment
    - brass drift driver
    - bubble balancer (static balance)
    - driving punch
    - seal driver
    - spin balance equipment (Hunter spin balance)
    - weight hammer
    - wheel bearing packer

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COURSE TEST: SUSPENSION SYSTEMS

37.10.01.01

1. Wheel shimmy can be removed by:
   - a. static balance.
   - b. dynamic balance.
   - c. alignment.
   - d. repairing front end.

2. Excessive wear on both outsides of the tire is due to:
   - a. unbalanced tire.
   - b. out-of-alignment.
   - c. over inflating.
   - d. under inflating.

3. Dynamic balance can eliminate:
   - a. wheel skip.
   - b. wheel tramp.
   - c. wheel shimmy.
   - d. wheel cupping.

4. Tires must run reasonably true to prevent:
   - a. vibrations and unbalance.
   - b. excessive wheel weight.
   - c. wearing out the idler arm.
   - d. tire blow out.

5. When a tire is in proper statis balance, the weight mass:
   - a. will be evenly distributed around the center of the drum.
   - b. is in the same plane as the center of the wheel.
   - c. will be evenly distributed around the axis of rotation.
   - d. is in the same plane as the axis of rotation.

37.10.01.02

6. Before placing the wheel on the balancer, the wheel should be inspected for:
   - a. rim damage.
   - b. incorrect tire size for the rim.
   - c. old remaining weights.
   - d. air leaks.

37.10.01.02 (continued)

7. To divide a needed 3/4 ounce weight on a balanced tire in order to split the weights, the mechanic would use:

   a. a 3/4 weight cut in half.
   b. 1/2 to 1/4 ounce weights.
   c. two 3/8 ounce weights.
   d. (cannot be split)

8. After the weights are positioned properly, they must also be:

   a. split up so half of the weight is on the direct opposite side.
   b. hammered into place exactly where they are.
   c. matched with the same amount of weight to be placed on the opposite side.
   d. divided into smaller weights before being installed.

9. Before the tire is placed on the balancer:

   a. it should be tapped with a light hammer near the bead.
   b. it should be tested for leaks.
   c. it should be bounced on the floor several times.
   d. it should be thoroughly cleaned.

10. Failing to clean a wheel before balancing will result in:

   a. the work area becoming unnecessarily dirty.
   b. damage to the wheel balancer.
   c. a balanced wheel becoming unbalanced.
   d. difficulty in fastening the weights to a dirt-embedded rim.

37.10.01.03

11. Before spin-balancing, the wheel does not need to be checked for:

   a. air inflation.
   b. tire size.
   c. clean of dirt.
   d. wheel bearing tension.

12. To spin a dragging disc brake, it may be necessary to temporarily remove the:

   a. rotor.
   b. disc pads.
   c. brake fluid pressure.
   d. caliper.

13. To spin-balance a posi-traction rear-end, the mechanic must:

   a. first use a bubble-balancer to obtain static balance.
   b. raise both wheels off the floor.
   c. raise only the needed tire to balance but reduce speed.
   d. remove the opposite tire with both wheels off the floor while balancing the one remaining tire.

37.10.01.03 (continued)

14. To raise the wheel off the floor for spinning, the jack should be placed beneath the car on the:

    a. floor pan.
    b. bumper.
    c. lower control arm.
    d. frame side.

15. Before attaching the wheel balancer equipment, the wheel should be checked for:

    a. improper tire size.
    b. wheel-out-of-alignment.
    c. loose wheel bearings.
    d. none of the above.

37.10.01.04

16. Front wheel bearings are of two types:

    a. tapered roller and non-tapered roller.
    b. ball and tapered roller.
    c. needle and ball.
    d. bushing and roller.

17. Wheel bearings:

    a. should be dried with a clean cotton rag.
    b. should never be oversoaked in carburetor cleaner.
    c. should not be removed with a steel drift.
    d. should never be spun with air pressure while drying.

18. Bearing "cone creeping":

    a. is a necessary spindle characteristic.
    b. must be prevented.
    c. can result in immediate replacement of the spindle.
    d. must be cured by cone replacement.

19. A car with excessive mileage or used in heavy service should have the spindle:

    a. retempered with heat.
    b. replaced.
    c. measured with a micrometer.
    d. checked with an application of crack detecting solution.

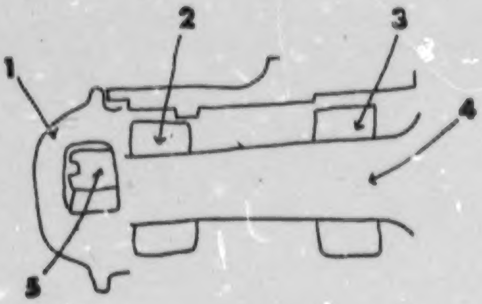
20. To insure adequate grease for the bearings:

    a. fill the hub center full of grease in between the bearings.
    b. work the grease into the bearing and add a coat to the bearing outside.
    c. fill the dust cap full of grease.
    d. fill the entire hub and cap full of grease.

37.10.01.05

21. Part #2 is referred to as the:*

    a. inside bearing
    b. outside bearing.
    c. spindle.
    d. hub.



22. Part #4 is referred to as the:*

    a. steering knuckle.
    b. hub.
    c. shaft.
    d. spindle.

23. Final rinsing of bearings should be in:

    a. clean solvent.
    b. carburetor cleaner.
    c. soapy warm water.
    d. clean gasoline.

37.10.01.06

24. The cup taper when installed should point to the:

    a. steering knuckle.
    b. outside of the hub.
    c. grease cup surface.
    d. inside of the hub.

25. The four main parts of the wheel bearing are:

    a. ball, cup, cone, bearing.
    b. race, cup, cage, bearing.
    c. cage, roller, cone, bearing.
    d. cup, cone, cage, bearing.

37.10.02.01

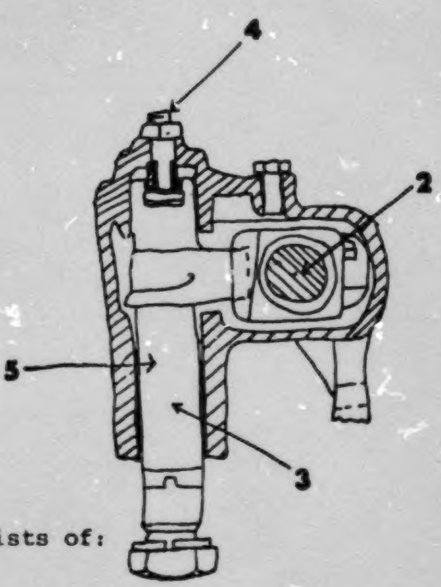
26. In the drawing at the lower right of a recirculating ball worm and nut steering gearbox, what part is #2?** (refer to page 5 drawing).

    a. worm
    b. seal
    c. side cover
    d. universal coupling

*(Adapted from Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, pages 30-31, Figures 30-36A).

**(Adapted from Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, page 317).

37.10.02.01 (continued)



27. In the drawing at the right, part #4 is:*

    a. a taper pin
    b. a ball nut.
    c. a worm shaft.
    d. an adjusting screw.

28. In the drawing at the right, part #5 is:*

    a. a taper pin
    b. a worm shaft.
    c. a worm.
    d. a pitman shaft.

29. The lubricant located in the steering gear box consists of:

    a. gear oil.
    b. grease.
    c. light motor oil.
    d. power steering fluid.

30. The steering gearbox:

    a. reduces the level of vibration of the vehicle.
    b. resists the revolutions of travel of the pitman arm.
    c. resists the transfer of road shocks to the driver.
    d. produces a more uncomfortable ride for the passengers.

37.10.02.02

31. The manual steering gearbox in popular use today employs what design?

    a. worm and roller manual gearbox.
    b. the worm and taper pin steering gearbox.
    c. the recirculation ball worm and nut design.
    d. rack and pinion.

32. Steering gearbox fluid changes:

    a. can only be done during gearbox overhauls.
    b. should be periodical.
    c. are necessary at every 30,000 miles.
    d. are not necessary if not contaminated.

33. Steering gear lubricant should be relatively _______________, yet should remain fluid at ___________________________ temperatures.

    a. viscous; high temperatures.
    b. viscous; low temperatures
    c. thin; low temperatures
    d. clean; normal

*(Adapted from Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, page 317).

37.10.02.03

34. Before disassembly of the manual gearbox:

    a. the housing should be thoroughly cleaned.
    b. the adjusting lash screw must be removed.
    c. the pitman arm and pitman shaft should be marked.
    d. the worm gear must be centered.

35. The adjusting screw in the end of the pitman shaft should not have free play over:

    a. .001
    b. .005
    c. .002
    d. .015

15.10.03.01

36. To maintain road feel, power steering systems require:

    a. them to be mounted somewhat loosely.
    b. scale wheel effort.
    c. them to be self-contained.
    d. them to have rack and pinion steering gearbox.

37. If the spool valve is in a neutral position, oil is fed:

    a. to the pitman shaft by the power piston.
    b. nowhere.
    c. only to the steering column connection.
    d. to both sides of the power piston, and to the reaction rings.

38. A power steering unit is designed:

    a. to reduce the steering wheel turning effort.
    b. for women primarily.
    c. for racing when quick turning is needed.
    d. to be used in the more sophisticated cars.

39. The worm shaft is connected to the steering shaft by a:

    a. brass bushing.
    b. 3/8" drive universal joint.
    c. any flexible connector.
    d. spool valve.

40. The feeling imparted to the steering wheel by the wheels of a car in motion is called:

    a. phantom pressure.
    b. power steering.
    c. turning effort.
    d. road feel.

37.10.03.02

41. A vibrating flow control valve in the pump usually indicates:

    a. overfilled with fluid.
    b. sticking valve.
    c. low on fluid in the reservoir.
    d. leaking pressure within the pump.

42. The majority of power steering pumps are:

    a. not equipped with any pressure control device.
    b. pressure-relieved when the wheels are straight ahead.
    c. partial flow.
    d. constant pressure flow.

37.10.03.03

43. Prior to reassembly of the power steering unit you should:

    a. lubricate the parts with power steering fluid.
    b. lubricate the parts with a light grease.
    c. clean them thoroughly and put them together dry.
    d. lubricate the parts with 30 weight oil.

44. When overhauling any hydraulic unit, one of the most important things is:

    a. painting the exterior.
    b. use of labor saving tools.
    c. cleanliness.
    d. speed.

37.10.03.04

45. The self-contained power steering system eliminates:

    a. worm.
    b. ball nut.
    c. the separate power cylinder.
    d. the bulky reservoir tank.

37.10.04.01

46. The semi-elliptical leaf spring is made up of:

    a. several coils.
    b. a number of flat steel springs.
    c. single flat steel leaf.
    d. a torsion bar.

37.10.04.01 (continued)

47. Most heavy cars support the front weight with the spring connected to the frame and the:

a. lower control arm.
b. upper control arm.
c. kingpin.
d. stabilizer bar.

48. The purpose of the shock absorber is to:

a. eliminate swaying of the car.
b. keep the tires from bouncing too fast.
c. fasten the body to the axles.
d. overcome spring oscillations.

49. The stabilizer bar is used to:

a. stabilize lower control arms.
b. overcome spring oscillations.
c. overcome unsprung weight.
d. overcome the tendency for car's body to lean on corners.

50. Caster angle, as applied to the steering system, is the:

a. amount each tire points in at the front.
b. inward and outward tilt of kingpin or ball joint at the top.
c. forward or backward tilt of kingpin or ball joint at the top.
d. amount each tier points out at the front.

37.10.04.02

51. To test a ball joint with the spring located between the upper control arm and the frame, the mechanic would need a:

a. support wedge.
b. smaller jack.
c. spring compressor.
d. ball joint wrench.

52. On a lower control arm mounted coil spring, it is necessary to:

a. chain up the upper control arm.
b. lower the lower control arm quickly after the joint is disconnected.
c. remove the coil spring with a pry bar.
d. place a jack stand beneath the control arm.

53. Some follower joints are welded to the arm and must be:

a. carefully cut out with an air chisel.
b. carefully cut out with a torch.
c. replaced as a complete unit.
d. replaced with an internal ball joint kit.

37.10.04.02 (continued)

54. Pressed ball joints are removed from the spindle:

a. with a special tool and a hammer.
b. with a special tool.
c. with a hammer.
d. by the use of heat.

37.10.04.03

55. Before installing the new tie-rod-end into place:

a. the tie-rod-end should be greased.
b. the tapered hole should be cleaned.
c. the thread protector should be installed on the threads.
d. the tie-rod-end socket should be lightly oiled.

37.10.04.04

56. The idler arm is bolted to:

a. the frame and linkage.
b. the frame and the pitman arm.
c. the pitman and the linkage.
d. the tie rod and tie rod center link.

57. As part of the installation, idler arms should be:

a. aligned.
b. oiled.
c. adjusted.
d. torqued.

58. For easier installation of idler arm repair kit components, a:

a. rubber lubricant can be used on the sliding bushings.
b. light coat of oil can be used on the sliding bushings.
c. light coat of heavy grease can be used on the sliding bushings.
d. application of clean solvent can be used.

37.10.04.05

59. While pressing the new bushings in the control arm pad to prevent collapsing the control arm around the bushing, it is recommended to use:

a. a high pressure press.
b. a low pressure press.
c. a spacer block.
d. a press ram.

60. To install bushings into a double arm bushing control car with a press, it is necessary to use what to prevent distortion?

a. stiffener plate.
b. spacer block.
c. a water pipe.

37.10.05.01

61. The turn-tables are not necessary to adjust the:

- a. caster.
- b. camber.
- c. riding height.
- d. toe-in.

62. During alignment set-up process, which component is not necessarily part of front-end check?

- a. control arm bushings.
- b. "U" joints.
- c. tie rod ends.
- d. ball joints.

37.10.05.02

63. To nearly be able to change camber without affecting caster, shims:

- a. should be removed from both bolts.
- b. must be removed from one bolt and added to the other.
- c. should be removed or added on one bolt.
- d. must be added to both bolts.

64. Positive caster is with the top of the wheel moved in the direction of the:

- a. headlight
- b. tail light
- c. engine
- d. fender opening

65. To sometimes overcome the wander effect of cars on a rough road, the alignment can be changed by adding more:

- a. positive camber.
- b. negative camber.
- c. positive caster.
- d. negative caster.

37.10.05.03

66. After the toe-in is adjusted, the front end should:

- a. be bounced and measured again.
- b. be measured again.
- c. test driven.
- d. greased.

67. Before adjusting the toe-in, the what should be centered?

- a. front tires.
- b. right tire.
- c. left tire.
- d. steering wheel.

37.10.05.03 (continued)

68. Tires with excessive toe-out will have the "feather-edge" to:

   a. both sides of the tire.
   b. the tire's inside.
   c. the tire's center.
   d. the tire's outside.

69. Tires which have excessive toe-in will result with the "feather-edge" on:

   a. the outside.
   b. the inside.
   c. the tire center.
   d. both sides of the tire.

70. Proper toe-in will allow the tires to move forward without:

   a. setting up a wheel tramp.
   b. a scrubbing, scraping action between tire and road.
   c. going into a wheel shimmy.
   d. causing a front-end vibration.

37.10.05.04

71. In performing a front end alignment, it is best to start out by adjusting the:

   a. strut rod.
   b. camber first.
   c. caster-camber together.
   d. caster first.

72. The eccentric and strut adjustment are most common on:

   a. Chrysler cars.
   b. light General Motors cars.
   c. heavy American Motors cars.
   d. heavy Ford cars.

37.10.05.05

73. Before the eccentric can be turned what must be done?

   a. oil the eccentric slide surface.
   b. loosen the lock bolt.
   c. remove the cotter key.
   d. loosen the lock nut.

37.10.05.06

74. What prevents the slides from moving when the alignment is completed?

    a. cotter pinned slide bolts.
    b. torqued down sliding bolts.
    c. lock nuts on the slide bolts.
    d. the weight of the car.

75. In moving the slide adjustment, it is easier to:

    a. loosen bolts enough to move both slides at the same time.
    b. loosen one bolt a little to pivot and loosen the other more to slide.
    c. loosen only the one slide that you intend to move.
    d. loosen one and tap the other with a hammer.

UNIT TEST ANSWER SHEET

Occupational Ares: Automotive
File Code: 37.10
Name:
Family Pay Number: Sex: M F (Circle 1)

ANSWERS

0101	1.	B
	2.	D
	3.	C
	4.	A
	5.	C
0102	6.	C
	7.	B
	8.	A
	9.	D
	10.	C
0103	11.	B
	12.	D
	13.	D
	14.	D
	15.	C
0104	16.	B
	17.	D
	18.	A
	19.	D
	20.	B
0105	21.	B
	22.	D
	23.	A
0106	24.	D
	25.	D
0201	26.	A
	27.	D
	28.	D
	29.	A
	30.	C
0202	31.	C
	32.	D
	33.	B
0303	34.	A
	35.	C
0301	36.	B
	37.	D
	38.	A
	39.	C
	40.	D
0302	41.	C
	42.	D
0303	43.	A
	44.	C
0304	45.	C
0401	46.	B
	47.	A
	48.	D
	49.	D
	50.	C
0402	51.	A
	52.	D
	53.	C
	54.	A
0403	55.	B
0404	56.	A
	57.	D
	58.	A
0405	59.	C
	60.	A

UNIT TEST ANSWER SHEET

Occupational Area: Automotive
File Code: 37.10
Name: ____________

ANSWERS

0501	61.	C
	62.	B
0502	63.	B
	64.	B
	65.	D
0503	66.	A
	67.	D
	68.	D
	69.	B
	70.	B
0504	71.	D
	72.	A
0505	73.	D
0506	74.	B
	75.	B
	76.	
	77.	
	78.	
	79.	
	80.	
	81.	
	82.	
	83.	
	84.	
	85.	
	86.	
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	117.	
	118.	
	119.	
	120.	

File Code: 37.10.01.00.B1-1

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Mountain-Plains Education & Economic Development Program, Inc.
Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: TIRE BALANCING

RATIONALE:

The fundamentals and techniques in this unit will enable one to balance tires, diagnose, replace and repack wheel bearings.

PREREQUISITES:

Math Skills at Level E
Communication Skills at Level E

OBJECTIVES:

Correctly identify the operation of tire balancing. Balance tires and replace and repack wheel bearings.

RESOURCES:

Printed Material

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation, 1972 or equivalent.

Audio/Visual

Super 8 Sound Films: Wheel Balancing

Educational Products, Inc.

DCA Educational Products, Inc.
Front Wheels (#FAA042).
Rear Wheels (#FAA052).
Run Out and Out of Balance (#FAA032).

Equipment

Automobile needing bearing service
Automobile needing tire balancing
Bearing grease
Brass drift driver
Bubble balancer
Compressed air
Cotter pin
Driving punch
Jack (lift)

Principal Author(s): J. Anderson/C. Schramm/W. Osland

Resources: Equipment continued

Jack stands
Race
Seal driver
Shop cloth
Solvent
Spin balance equipment
Tools, Basic Hand:

- Chisel and Punch Set
  - 5/32" Pin Punch
  - 3/16" Solid
- Gauge, feeler (.002" - .025")
- Hammer, ball peen
- Hammer, plastic tip
- Handle, speed
- Hex Key Set
- Pliers, diagonal cutting
- Pliers, needle nose
- Scraper, gasket
- Screwdriver, standard (Set)
- Screwdriver, phillips (Set)
- Screw starter
- Socket Set (3/8" drive)
  - extension (3")
  - ratchet
- Socket Set (1/4" drive)
  - extension (3")
  - handle (6" flex)
  - ratchet
- Socket, spark plug
  - extension (6")
- Wrench, combination (Set)
- Wrench, combination ignition (Set)

Torque wrench
Weights
Weight hammer
Wheel bearings
Wheel bearing packer

GENERAL INSTRUCTIONS:

This unit consists of six Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Tire Balancing
.02 Static Balance (Bubble - Type)
.03 Spin Balance
.04 Fundamentals and Types of Wheel Bearings
.05 Cleaning and Inspection of Wheel Bearings
.06 Replacement of Wheel Bearings

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing;

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: ______________________ File Code: 37.10.01.00.B1-2

Date: ______________________ Date Published: 3/11/76

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UNIT PRE-TEST: TIRE BALANCING

37.10.01.01.

1. Excessive wear in the center of the tire tread is due to:

   a. under inflating.
   b. over inflating.
   c. unbalanced tire.
   d. out-of-alignment.

2. Tires (to maintain longer life) should be rotated about every:

   a. 20,000 miles.
   b. 10,000 miles.
   c. 5,000 miles.
   d. 25,000 miles.

3.

4. Static unbalance is corrected by clipping lead weights to the rim edge:

   a. close to the heavyside.
   b. on the heavy side.
   c. opposite the heavy side.
   d. opposite the light side.

5. "Wheel shimmy":

   a. cannot be removed by dynamic balancing.
   b. is caused by worn front-end components.
   c. can be removed with static balancing.
   d. causes greater wear on the front-end parts.

37.10.01.02.

6. To test a newly balanced tire for accuracy, the mechanic can:

   a. test drive the car.
   b. place the tire back on the balancer.
   c. mark the position of the weights, remove them, and rebalance to see if they rebalance themselves as before.
   d. have someone else rebalance the tire after the weights were marked and removed.

37.10.01.02. cont.

7.

8. Bubble type balance will remove what from a problem wheel?

   a. alignment problems.
   b. dynamic unbalance.
   c. wheel shimmy.
   d. static unbalance.

9. Common wheel weights are available in sizes of:

   a. 1/8 oz.
   b. 1/4 oz.
   c. 1/3 oz.
   d. 1/16 oz.

10. Tire air pressure should be checked on a tire:

   a. before it is placed on the balancer.
   b. after it has been balanced.
   c. after it is replaced back on the vehicle.
   d. during the hammer installation of the weights.

37.10.01.03.

11. When the spin-balancer has indicated the correct needed weight, the mechanic should:

   a. place the weight on the inside of the wheel.
   b. split the weight in half for both sides of the wheel.
   c. place the weight on the outside of the wheel.
   d. add the same amount of registered weight to the inside.

12. A sure-way check of satisfactory spin balance would be to:

   a. have someone else respin the wheel.
   b. remove balancer and spin while observing for vibration.
   c. respin and have the balancer indicate "no weight needed."
   d. remove the marked weights and spin again.

13. The greatest danger of spin-balancing is the possibility of:

   a. wheel weights coming off.
   b. the spin-balancer coming loose.
   c. the car falling off the jack.
   d. flying embedded pebbles or rocks.

37.10.01.03. cont.

14. Spin-balancing:

    a. is less time consuming than bubble balance.
    b. is more effective because it balances all spinning parts.
    c. costs less because of less time needed to operate.
    d. lasts longer than bubble balancing on tires.

15. Excessively edge-cupped tires:

    a. can be exchanged from side to side and balanced to save the tire.
    b. should be discarded.
    c. should be placed on the rear and carefully balanced to save the tire.
    d. can be stopped by shock replacement.

37.01.01.04.

16. If only the bearing cup shows damage:

    a. both bearings should be replaced.
    b. the cup needs only to be replaced.
    c. the cup and cone should be replaced.
    d. the entire bearing should be replaced.

17. Bearing grease applied to an oily bearing:

    a. insures that the bearing is well lubricated.
    b. will not adhere.
    c. allows time for the grease to work in and around the bearing.
    d. will cause the grease to stick heavily to the bearing cup.

18. Poor brake performance, wheel shake, poor steering, and rapid bearing wear can be easily caused by:

    a. insufficient bearing lubricant.
    b. improper bearing adjustment.
    c. worn "U" joints.
    d. improper brake shoe adjustment.

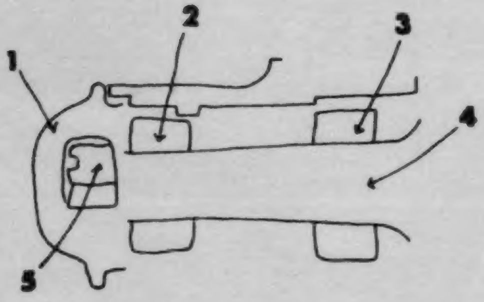
19. Wheel bearing adjustment can be measured with:

    a. torque wrench or a spring tension gauge.
    b. torque wrench or a feeler gauge.
    c. dial indicator or micrometer.
    d. torque wrench or dial indicator.

20. The cotter key ends should:

    a. not protrude outside the lock nut.
    b. clear all moving parts.
    c. both be bent out and over the spindle end.
    d. be hammered flat to insure a tight fit.

37.10.01.05.



21. Part #3* is referred to as the:

    a. hub.
    b. outside bearing.
    c. spindle.
    d. inside bearing.

22. Inspection of a cleaned bearing can be more effectively done with a:

    a. trouble light.
    b. magnifying glass.
    c. magna-flux.
    d. mirror.

23. Bearings that need cleaning, inspecting and packing that are often neglected and therefore fail are the:

    a. inside front hub bearings.
    b. inner carrier bearings.
    c. pinion bearings.
    d. outside axle bearings.

37.10.01.06.

24.

25. To insure exact bearing replacement, the mechanic should:

    a. use the car identification.
    b. measure the bearing.
    c. refer to the number on the old bearings.
    d. none of the above.

---

* (Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox, 1975, p. 30-13, Fig. 30-36A.)

UNIT PRETEST ANSWER KEY: TIRE BALANCING

LAP .01

1. b
2. c
3. a
4. c
5. d

LAP .02

6. b
7. d
8. d
9. b
10. a

LAP .03

11. b
12. c
13. d
14. b
15. c

LAP .04

16. d
17. b
18. b
19. d
20. b

LAP .05

21. d
22. a
23. d

LAP .06

24. b
25. c

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Fundamentals of Tire Balancing

OBJECTIVE:

Recognize the operation of and the purpose for tire balancing.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple-choice objective test about this LAP.

80% correct on LAP study questions.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.
Auto Service and Repair, Stockel.

Filmstrips:

Front Wheels--#FAA042.
Rear Wheels--#FAA052.
Run-Out and Out-of-Balance--#FAA032.

Projector

PROCEDURE:

NOTE: Review pages 30-26 through 30-29 in Auto Service and Repair.

1. Do the following assignments using Auto Mechanics Fundamentals.
   a. Read Capter 16, "Tire Run-Out", pages 308-310.

      NOTE: Study diagrams and chart.
   b. Answer quiz questions 16, 17 and 18 on page 311 on your answer sheet.
   c. Return text to shelf and return your answer sheet to the instructor.
2. Obtain and view filmstrips listed above under "RESOURCES". Return the films.
3. Take and score the LAP test.
4. Upon successful completion, proceed to the next LAP.

Principal Author(s):

J. Anderson/W. Osland

Student: ______________________ **File Code:** 37.10.01.01.B1-2

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LAP TEST: FUNDAMENTALS OF TIRE BALANCING

1. Tires must run reasonably true to prevent:
   a. vibrations and unbalance.
   b. excessive wheel weight.
   c. wearing out the idler arm.
   d. tire blowout.

2. Tire runout is not as critical as wheel runout because:
   a. the tire will wear off the runout part as it is used.
   b. tires can be balanced to cure runout problems.
   c. the tire itself can absorb some of its own inaccuracy through flexing.
   d. none of the above.

3. An unbalanced tire that hops up and down is referred to as the condition of:
   a. dynamic balanced.
   b. wheel shimmy.
   c. static balanced.
   d. wheel tramp.

4. Wheel shimmy can be removed by:
   a. static balance.
   b. dynamic balance.
   c. alignment.
   d. adding more air to the tires.

5. Excessive wear in the center of the tire tread is due to:
   a. under inflating.
   b. over inflating.
   c. unbalanced tire.
   d. out-of-alignment.

6. Excessive wear on both outsides of the tire is due to:
   a. over inflating.
   b. under inflating.
   c. unbalanced tire.
   d. out-of-alignment.

7. Tires (to maintain longer life) should be rotated about every:
   a. 20,000 miles.
   b. 10,000 miles.
   c. 5000 miles.
   d. 25,000 miles.

8. Ply rating of tires is determined by:

   a. the number of actual plies of the tire.
   b. the load carrying ability of the tire.
   c. the manufacturing cost of the tire.
   d. size of the tire diameter.

9. Static unbalance is corrected by clipping lead weights to the rim edge:

   a. close to the heavy side.
   b. on the heavy side.
   c. opposite the heavy side.
   d. opposite the light side.

10. Static balance of tires requires:

   a. four weights of the same size divided between front and back of wheel.
   b. four weights of same size distributed evenly around the rim.
   c. two weights placed as needed to balance the front side of the tire and two weights placed as needed to balance the back side of tire.
   d. two weights on front side of the wheel.

LAP TEST ANSWER KEY: FUNDAMENTALS OF TIRE BALANCING

1. A
2. C
3. D
4. B
5. B
6. B
7. C
8. B
9. C
10. A

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Learning Activity Package

Student: __________

Date: __________

PERFORMANCE ACTIVITY: Static Balance (Bubble-type)

OBJECTIVE:

Identify the procedure and equipment necessary for static balancing of tires and wheels; static balance tire and wheels.

EVALUATION PROCEDURE:

Eight correct responses to a ten-item multiple choice objective test.
80% correct on performance checklist.

RESOURCES:

Automobile needing tire balancing
Bubble balancer
Weights
Weight hammer

Auto Service and Repair, Stockel.

PROCEDURE:

NOTE: Review pages 30-23 through 30-24 in Auto Service and Repair.

1. Clean tire and rim.
   NOTE: Heavy dirt or grease on wheel will affect wheel balance.
2. Remove all old weights from wheel.
3. Shift the control lever of the balancer to the ON position.
   NOTE: You must hold the lever in the ON position by hand.
4. Adjust the three legs under the balancer so that the bubble is centered.
5. Place the wheel assembly on the balancer.
   NOTE: The arrow on the dial of the balancer must point to the valve stem.
6. Move the lever to the ON positon.
   NOTE: If the bubble does not center in the small circle of the dial, the wheel is not in balance.
7. Check bubble position to determine the light spot on the wheel.
   NOTE: The bubble will go toward the light spot.

Principal Author(s): J. Anderson/W. Osland

8. Mark the light spot over with chalk.
9. Select four weights of equal size.
   NOTE: When laid on the wheel at the chalk mark, they will cause the bubble to move past center toward opposite side of wheel. Weights must not be too heavy to cause bubble to move to the extreme edge of the bubble cage.
10. Place selected weights in pairs on either side of the small chalk mark.
    NOTE: Place weights on edge of rim.
11. Move the weights in pairs a small distance at a time, away from the chalk mark.
    NOTE: As the weights are moved farther apart, you will notice the bubble moving back toward the center or balanced position.
12. Adjust position of weights IN PAIRS until the bubble is exactly centered.
    NOTE: When bubble is centered, wheel is balanced.
13. Shift balancer control lever to OFF position.
14. Mark position of the weights with chalk marks.
15. Remove wheel from balancer.
16. Attach weights to wheel at the chalk marks which marked position when bubble was centered.
    NOTE: Each pair of weights are to be attached to the front and back of the wheel at the chalk marks.
17. Recheck balance after weights are installed.
18. Remount wheel on vehicle front.
19. Clean work area.
20. Have Instructor check your work.
21. Take and score the LAP test.
22. Upon successful completion of LAP test, proceed to the next LAP.

Student: ____________________ File Code: 37.10.01.02.B1-2

Date: ____________________ Date Published: 3/10/76

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LAP TEST: STATIC BALANCE (BUBBLE TYPE)

1. Before the tire is placed on the balancer:
   a. it should be tapped with a light hammer near the head.
   b. it should be tested for leaks.
   c. it should be bounced on the floor several times.
   d. it should be thoroughly cleaned.

2. The balancer (before using) should be checked for:
   a. damage.
   b. leaks.
   c. correct fluid level.
   d. floor accuracy.

3. To test a newly balanced tire for accuracy, the mechanic can:
   a. test drive the car.
   b. place the tire back on the balancer.
   c. mark the position of the weights, remove them and rebalance to see if they rebalance themselves as before.
   d. have someone else rebalance the tire after the weights were marked and removed.

4. Before the weights are hammered into place:
   a. the wheel should have a rebalance check.
   b. the wheel should be removed.
   c. the weights should be examined for weak points.
   d. the balance trip lever should be de-activated.

5. Bubble type balance will remove what from a problem wheel?
   a. alignment problems.
   b. dynamic unbalance.
   c. wheel shimmy.
   d. static unbalance.

6. Failing to clean a wheel before balancing will result in:
   a. the work area becoming unnecessarily dirty.
   b. damage to the wheel balancer.
   c. a balanced wheel becoming unbalanced.
   d. difficulty in fastening the weights to a dirt-embedded rim.

7.

8. To divide a needed 3/4 ounce weight on a balanced tire in order to split the weights, the mechanic would use:

   a. a 3/4 weight cut in half
   b. 1/2 and 1/4 ounce weights.
   c. two 3/8 ounce weights.
   d. (cannot be split).

9. Before placing the wheel on the balancer, the wheel should be inspected for:

   a. proper rim width.
   b. incorrect tire size for the rim.
   c. old remaining weights.
   d. air leaks.

10. Tire air pressure should be checked on a tire:

    a. before it is placed on the balancer.
    b. after it has been balanced.
    c. after it is replaced back on the vehicle.
    d. during the hammer installation of the weights.

LAP TEST ANSWER KEY: STATIC BALANCE (BUBBLE TYPE)

1. d
2. d
3. b
4. d
5. d
6. c
~~7. b~~
8. b
9. c
10. a

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Spin Balance

OBJECTIVE:

Identify the procedure and equipment needed for spin balancing tires. Spin balance a set of tires needing balancing.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.

Automobile needing tire balance
Hand tools, basic (See Unit LEG)
Jack (or lift)
Jack stands
Spin balance equipment
Weights
Weight hammer

PROCEDURE:

NOTE: Review pages 30-23 through 30-25 in Auto Service and Repair (dynamic balance and spin balance are the same).

1. Position floor jack under frame of automobile. Raise the wheel one inch off the floor.
2. Remove the hubcap and any wheel weights (both sides of the tire).
3. Clean the rim and tire of any excess dirt and grease.
4. Mount the rim attachment securely and properly to the rim. Have the instructor or experienced student double-check your mounting. IT MUST BE SAFE AND SECURE!
5. Attach weight control units properly to the rim attachment.
6. Be sure knobs are in neutral or no-weight position. Look through the gauge window to check.
7. Remember this:
   RIGHT TIRE: 1st knob from center adds weight.
   (Passenger side): 2nd knob from the center subtracts weight.

Principal Author(s): J. Anderson/W. Osland

7. (continued)
   LEFT TIRE: 2nd knob from the center adds weight.
   (Driver's side): 1st knob from the center subtracts weight.

   The Green Knobs (the outer pair): One moves the weight toward the center. The other moves the weight away from the center.

8. Position the spinner next to the tire and lock. Spin the tire at a relatively safe speed and watch the fender for vibrations. (Release the spinner after desired speed is reached.)
9. Add a little weight (while spinning). Move this weight back and forth with the outside pair of knobs until vibration of fenders changes to the minimum.
10. Now add more weight and move the weight until you can reach the last amount of vibration.
11. Stop the wheel and read the amount of weight needed on the gauge. Apply the weight on the rim at the point where the gauge needle indicates.
    NOTE: If the desired weight is unattainable, stoop the wheel and add a 3 ounce weight on the inside edge of the wheel in the direction of the arrow. Then continue to spin and secure new weight adjustment.
12. Double-check your work by spinning the tire up to the desired speed and look for fender vibration. Upon completion, remove all equipment.
13. The same method is used for the rear wheels, with one exception. Instead of using the spinner, start the car and run it up to the speed of 35 mph on the speedometer, or the point of the most vibration.
14. The instructor will check your completed work.
15. Take and score the LAP test.
16. Upon successful completion, proceed to the next LAP.

Student: ______________________ **File Code:** 37.10.01.03.B1-2

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LAP TEST: SPIN BALANCE

1. Before spin-balancing, the wheel does not need to be checked for:

   a. wheel bearing tension
   b. mud/dirt accumulation
   c. tire size (width)
   d. air inflation

2. To raise the wheel off the floor for spinning, the jack should be placed beneath the car on the:

   a. floor pan.
   b. bumper.
   c. lower control arm.
   d. frame side.

3. To spin-balance a posi-traction rear end, the mechanic must:

   a. remove the opposite tire with both wheels off the floor while balancing the one remaining tire.
   b. raise only the needed tire to balance but reduce speed.
   c. raise both wheels off the floor.
   d. first use a bubble-balancer to obtain static balance.

4. In spin-balancing, the speed of non posi-traction or non no-spin rear end at the speedometer would be approximately:

   a. 70 mph.
   b. 50 mph.
   c. 35 mph.
   d. 25 mph.

5. When the spin-balancer has indicated the correct needed weight, the mechanic should:

   a. place the weight on the inside of the wheel.
   b. split the weight in half for both sides of the wheel.
   c. place the weight on the outside of the wheel.
   d. add the same amount of registered weight to the inside.

6. A driver says that the front end of his car vibrates up and down while travelling at most road speeds:

   Mechanic "A" says that too much runout of the front tires could be the cause.
   Mechanic "B" says that static out-of-balance of the front tires could be the cause. -- Who could be right?

   a. "A" only
   b. "B" only
   c. Either "A" or "B"
   d. Neither "A" nor "B"

7. A sure-way check of satisfactory spin-balance would be to:

    a. have someone else re-spin the wheel.
    b. remove balancer and spin while observing for vibration.
    c. re-spin and have the balancer indicate "no weight needed".
    d. remove the marked weights and spin again.

8. The greatest danger of spin-balancing is the possibility of:

    a. wheel weights coming off.
    b. the spin-balancer coming loose.
    c. rocks being thrown from the tread grooves.
    d. all of the above.

9. Dynamic imbalance means the:

    a. out of balance mass is in the centerline of the tire plane of rotation.
    b. out of balance mass is not in the center line of the tire.
    c. tire will tramp at highway speeds.
    d. tire will shimmy at low speeds but will smooth out as speed increases.

10. The largest advantage of spin balancing is that it:

    a. is more time consuming than bubble-balance.
    b. is more effective because it balances all spinning parts.
    c. costs more because of more time needed to operate.
    d. lasts longer than bubble-balancing on tires.

LAP TEST ANSWER KEY: SPIN BALANCE

1. C
2. D
3. A
4. C
5. B
6. B
7. C
8. D
9. B
10. B

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Mountain-Plains Education &
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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Fundamentals and Types of Wheel Bearings

OBJECTIVE:

Recognize the types and the purpose of wheel bearings.

EVALUATION PROCEDURE:

Score 80% correct on LAP study questions.

Score eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.

PROCEDURE:

1. Do the following assignments using Auto Service and Repair.
    a. Read Chapter 30, "Front Wheel Bearings", pages 30-12 through 30-18.
    b. Study figures 30-36 through 30-49.
    c. On separate paper, neatly answer questions 13 through 19.
    d. Turn answer sheet into the instructor for evaluation.
    e. Return textbook to shelf.
2. Take and score the LAP test.
3. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: ______________________ File Code: 37.10.01.04.B1-0

Date: ______________________ Date Published: 3/10/76

Mountain-Plains Education &
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LAP TEST: FUNDAMENTALS AND TYPES OF WHEEL BEARINGS

1. To remove the hub on disc brakes, it is necessary to remove the:

   a. disc pads.
   b. rotor.
   c. backing plate.
   dd caliper.

2. During any bearing or brake service, it is recommended to:

   a. preload the old bearings.
   b. replace the bearing cage.
   c. test drive the car.
   d. replace the grease seal.

3. If only the bearing cup shows damage:

   a. both bearings should be replaced.
   b. the cup needs only to be replaced.
   c. the cone should be replaced.
   d. the entire bearing should be replaced.

4. To insure adequate grease for the bearings:

   a. fill the hub center full of grease in between the bearings.
   b. work the grease into the bearing and add a coat to the bearing outside.
   c. fill the dust cap full of grease.
   d. fill the entire hub and cap full of grease.

5. A car with excessive mileage or used in heavy service should have the spindle:

   a. retempered with heat.
   b. replaced.
   c. measured with a micrometer.
   d. checked with an application of crack detecting solution.

6. Bearing "cone creeping":

   a. is a necassary spindle characteristic.
   b. must be prevented.
   c. can result in immediate replacement of the spindle.
   d. must be cured by cone replacement.

7. Poor brake performance, wheel shake, poor steering, and rapid bearing wear can be easily caused by:

   a. insufficient bearing lubricant.
   b. improper bearing adjustment.
   c. worn "U" joints.
   d. improper brake shoe adjustment.

8. Desired roller bearing end play is from:

   a. .0001 to .0003
   b. .050 to .001
   c. .01 to .03
   d. .001 to .003

9. Wheel bearing adjustment can be measured with:

   a. torque wrench or a spring tension gauge.
   b. torque wrench or a feeler gauge.
   c. dial indicator or micrometer.
   d. torque wrench or dial indicator.

10. Recommended ball bearing end play is about:

   a. .001 to .003
   b. .000 to a mild preload.
   c. .003 to .005
   d. .0001 to .0005

LAP TEST ANSWER KEY: FUNDAMENTALS AND TYPES OF WHEEL BEARINGS

1. d
2. d
3. d
4. b
5. d
6. a
7. b
8. d
9. d
10. b

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File Code: 37.10.01.05.B1-0

Date Published: 3/10/76

Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Cleaning & Inspecting Wheel Bearings

OBJECTIVE:

Identify the procedure for removing, cleaning, inspecting, repacking, installing and adjusting the front wheel bearings. Remove, clean, inspect, repack, and install a set of wheel bearings.

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after doing LAP 37.10.01.06.

RESOURCES:

Auto Service and Repair, Stockel.

Automobile needing bearing service
Bearing grease
Compressed air
Cotter pin
Seal driver
Service Manual
Shop cloth
Solvent
Tools, basic hand (See Unit LEG)
Torque wrench
Wheel bearing packer

PROCEDURE:

NOTE: Review page 30-13 in Auto Service and Repair.

1. Lift the front of the car with a floor jack until the wheels clear the floor and put safety stands under the car.
2. Remove the spindle nut and outer wheel bearing. NOTE: After the nut is removed, hit the side of the tire at the top to cause the thrust washer and bearing to come loose.
3. Remove the wheel and hub assembly from the spindle by lifting up and pulling on the wheel. NOTE: Be careful not to damage brake shoes as the drum is pulled off.
4. Remove the dirt from the brake assembly and from inside the brake drum with an air blast.

Principal Author(s): J. Anderson/W. Osland

5. Wipe the spindle clean with a shop cloth. CAUTION: Do not get grease on the brake shoes or inside the brake drum.
6. Wipe the inside of the hub and races clean with a shop cloth and wash the bearings in solvent and blow dry with compressed air. NOTE: Do not spin bearings with air.
7. Inspect bearings and races for nicks, burrs, pits and overheating. NOTE: If bearings look bad, they should be replaced. Check with instructor.
8. Check the races inside the hub, making sure they are tightly in place.
9. Repack the bearings using a wheel bearing packer and put a very light coat of fresh bearing grease on the races.
10. Install inside seal and bearing by using a seal driver. NOTE: Check brake drum to be sure there is no grease on it.
11. Push drum and wheel over the spindle and brake shoes. NOTE: Be careful not to damage the brake shoes.
12. Install outer wheel bearing, thrust washer and nut. NOTE: Be sure that the small end of bearing is to the inside.
13. Tighten nut until there is no side play. NOTE: Tighten to specified pressure using a torque wrench.
14. Spin the wheel to be sure it turns freely. NOTE: Check with your instructor.
15. Install new cotter pin by bending the long prong around the nut.
16. Replace dust cover and hub cap.
17. Upon completion of the LAP, proceed to the next LAP.

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Learning Activity Package

Student: ______________________

Date: ______________________

PERFORMANCE ACTIVITY: Replacement of Wheel Bearings

OBJECTIVE:

Recognize the correct procedure for removal and replacement of wheel bearings.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Automobile needing bearing replacement
Bearing grease
Brass drift driver
Cotter key
Driving punch
Jack
Jack stands
Race
Repalcement wheel bearings
Torque wrench

PROCEDURE:

NOTE: Review pages 30-12 through 30-18 in Auto Service and Repair. (See Fig. 30.49.)

1. Raise vehicle and place jack stands.
2. Remove the hub cap, grease cup, cotter key, spindle nut and washer.
3. Tap the top of the tire to dislodge the outside wheel bearing. Remove bearing and re-install the spindle nut.
4. Grasp both sides of the tire and pull the wheel off the spindle. The nut will force the outer bearing and seal out of the hub as the wheel slides over it.
5. Remove nut, bearing and seal.
6. Clean the remaining bearing, seal, nut, and washer in clean solvent.
7. Air dry and place on a clean rag. CAUTION: Do not spin the bearing with air.

Principal Author(s): J. Anderson/W. Osland

8. Using a light, inspect the rollers, inner race between the rollers, roller cage, outer bearing race in the hub for damage or wear.
9. With the defective race in the hub down, use a long driving punch and hammer through the hub center to force the bearing race evenly out of the hub.
10. Compare the old race to the new race to be sure of proper replacement parts.
11. Use a brass drift driver to evenly force the new race into the hub. Be sure it is fitted against the proper edge of the hub.
12. Using the bearing packer, fill the two bearings full of grease.
13. Coat the outside of the rollers of the inner bearing with grease and place in the hub race. Install the seal.
14. Install the wheel on the spindle.
15. Coat the rollers of the outer bearing with grease and install in wheel.
16. Install the washer and nut.
17. Tighten the spindle nut to the correct torque with a torque wrench. Refer to the repair manual for the correct torque.
18. Install a new cotter key.
19. Ask the instructor to evaluate your work.
20. Install grease cap, hub cap.
21. Lower vehicle.
22. Clean and return all tools and equipment.
23. Clean work area.
24. **Take and score the combined LAP test.**

Student: ______________________ File Code: 37.10.01.05.B1-2
37.10.01.06.B1-2

Date: ______________________ Date Published: 3-10-76

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LAP TEST: CLEANING, INSPECTION AND REPLACEMENT OF WHEEL BEARINGS

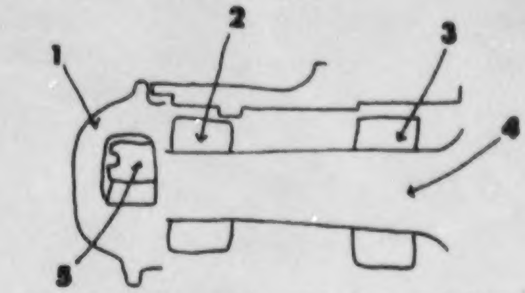
37.10.01.05

1. Final rinsing of bearings should be in:

   a. clean solvent.
   b. carburetor cleaner.
   c. soapy warm water.
   d. clean gasoline.

2. Part #4* is referred to as the:

   a. steering knuckle.
   b. hub.
   c. shaft.
   d. spindle.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Wilcox, 1975, page 30-13, Fig. 30-36A).

3. Inspection of a cleaned bearing can be more effectively done with a:

   a. trouble light.
   b. feeler gauge.
   c. magna-flux.
   d. mirror.

4. Although there are variations in wheel bearing adjusting technique between manufacturers, most are attempting to secure bearing (roller) end play of:

   a. .0001" to .0003"
   b. .010" to .030"
   c. .004" to .007"
   d. .001" to .003"

5. Proper ball bearing adjustment calls for:

   a. the same adjustment on roller bearings.
   b. zero end play to mild preload.
   c. preload of 15 to 20 foot pounds.
   d. hand tight then back off the nut one turn.

37.10.01.06

6. In some removal from the hub, it is recommended not to use a:

   a. soft steel drift.
   b. hardened steel drift.
   c. brass drift.
   d. wooden dowel.

37.11.01.06

7. To insure exact beraing replacement, the mechanic should:

   a. use the car identification.
   b. measure the bearing.
   c. all of these.
   d. refer to the number on the old bearings.

8. A "bluing" color of a bearing:

   a. indicates it was overheated at one time.
   b. is a manufacturing trade mark of some companies.
   c. is a result of heat used to temper the bearing metal.
   d. is natural of bearings and is nothing for the mechanic to worry about.

9. When adjusting wheel bearings on cars equipped with disc brakes:

   a. you can get a better adjustment of the bearing while someone is holding the brakes applied.
   b. you can get a better "feel" of the bearing by loosening the adjusting nut about 3 turns and wobbling the wheel back and forth before proceeding with the adjustment.
   c. the same procedure is used as with drum brakes.
   d. it is necessary to remove the wheel in some instances where difficulty is encountered.

10. If a bearing race has heat welded itself to a spindle during failure, it would be advisable to:

   a. cut the race off with a torch.
   b. replace the spindle.
   c. hammer the race until it is loose.
   d. replace the entire wheel assembly.

LAP TEST ANSWER KEY: CLEANING, INSPECTION AND REPLACEMENT OF WHEEL BEARINGS

LAP 05

1. A
2. D
3. A
4. D
5. B

LAP 06

6. B
7. C
8. A
9. B
10. B

Student: ______________________ File Code: 37.10.01.00.C1-2 (A)

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UNIT POST TEST: TIRE BALANCING (A)

37.10.01.01.

1. Tires must run reasonably true to prevent:

   a. vibrations and unbalance.
   b. excessive wheel weight.
   c. wearing out the idler/arm.
   d. tire blowout.

2. When a tire is in proper static balance, the weight mass:

   a. will be evenly distributed around the center of the drum.
   b. is in the same plane as the center of the wheel.
   c. will be evenly distributed around the axis of rotation.
   d. is in the same plane as the axis of rotation.

3. Dynamic balance can eliminate:

   a. wheel skip.
   b. wheel tramp.
   c. wheel shimmy.
   d. wheel cupping.

4. A properly balanced tire is:

   a. static balanced.
   b. static and dynamic balanced.
   c. dynamic balanced.
   d. shimmy balanced.

5. "Wheel shimmy":

   a. cannot be removed by dynamic balancing.
   b. is caused by worn front-end components.
   c. can be removed with static balancing.
   d. causes greater wear on the front-end parts.

37.10.01.02.

6.

37.10.01.02. cont.

7. After the weights are positioned properly, they must also be:

   a. split up so half of the weight is on the direct opposite side.
   b. hammered into place exactly where they are.
   c. matched with the same amount of weight to be placed on the opposite side.
   d. divided into smaller weights before being installed.

8. To test a newly balanced tire for accuracy, the mechanic can:

   a. test drive the car.
   b. place the tire back on the balancer.
   c. mark the position of the weights, remove them and rebalance to see if they rebalance themselves as before.
   d. have someone else rebalance the tire after the weights were marked and removed.

9. Common wheel weights are available in sizes of:

   a. 1/8 oz.
   b. 1/4 oz.
   c. 1/3 oz.
   d. 1/16 oz.

10. To divide a needed 3/4 ounce weight on a balanced tire in order to split the weights, the mechanic would use:

   a. a 3/4 weight cut in half.
   b. 1/2 and 1/4 ounce weights.
   c. two 3/8 ounce weights.
   d. (cannot be split).

37.10.01.03.

11. To raise the wheel off the floor for spinning, the jack should be placed beneath the car on the:

   a. floor pan.
   b. bumper.
   c. lower control arm.
   d. frame side.

12. The speed of non posi-traction or non no-spin rear end at the speedometer would be approximately:

   a. 70 mph.
   b. 50 mph.
   c. 35 mph.
   d. 25 mph.

37.10.01.03. cont.

13. When the spin balancer has indicated the correct needed weight, the mechanic should:

    a. place the weight on the inside of the wheel.
    b. split the weight in half for both sides of the wheel.
    c. place the weight on the outside of the wheel.
    d. add the same amount of registered weight to the inside.

14. Before attaching the wheel balancer equipment, the wheel should be checked for:

    a. improper tire size.
    b. wheel-out-of-alignment.
    c. loose wheel bearings.
    d. none of the above.

15. Excessively edge-cupped tires:

    a. can be exchanged from side to side and balanced to save the tire.
    b. should be discarded.
    c. should be placed on the rear and carefully balanced to save the tire.
    d. can be stopped by shock replacement.

37.10.01.04.

16. Front wheel bearings are of two types:

    a. bushing and roller.
    b. needle and ball.
    c. ball and tapered roller.
    d. tapered roller and non-tapered roller.

17. Wheel bearings:

    a. should never be spun with air pressure while drying.
    b. should not be removed with a soft steel drift.
    c. should never be oversoaked in solvent.
    d. should be dried with a clean cotton rag.

18. Bearing grease applied to an oily bearing:

    a. insures that the bearing is well lubricated.
    b. will not adhere.
    c. allows time for the grease to work in and around the bearing.
    d. will cause the grease to stick heavily to the bearing cup.

19. Desired roller bearing end play is from:

    a. .0001 to .0003
    b. .050 to .001
    c. .01 to .03
    d. .001 to .003

37.10.01.04. cont.

20. The cotter key ends should:

    a. not protrude outside the lock nut.
    b. clear all moving parts.
    c. both be bent out and over the spindle end.
    d. be hammered flat to insure a tight fit.

37.10.01.05.

21. Wheel bearings can be packed by a special machine packer or by:

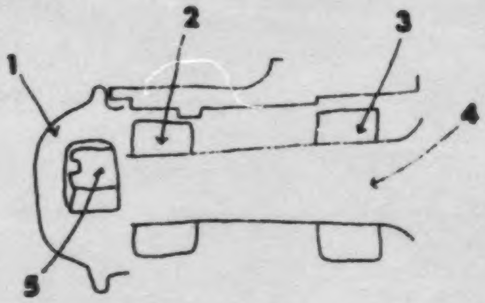
    a. none of the below.
    b. filling the hub and bearings on the spindle.
    c. soaking over night in the grease container.
    d. hand.

22. Part #2* is referred to as the:

    a. inside bearing.
    b. outside bearing.
    c. spindle.
    d. hub.

23. Part #3* is referred to as the:

    a. hub.
    b. outside bearing.
    c. spindle.
    d. inside bearing.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Wilcox, 1969, p. 30-13, Fig. 30-36A.)

37.10.01.06.

24.

25. The four main parts of the wheel bearing are:

    a. ball, cup, cone, bearing.
    b. cup, cone, cage, bearing.
    c. cage, roller, cone, bearing.
    d. race, cup, cage, bearing.

UNIT POST TEST ANSWER KEY: TIRE BALANCING (A)

LAP .01

1. a
2. c
3. c
4. b
5. d

LAP .02

[illegible]
7. a
8. b
9. b
10. b

LAP .03

11. d
12. c
13. b
14. c
15. c

LAP .04

16. c
17. a
18. b
19. d
20. b

LAP .05

21. d
22. b
23. d

LAP .06

~~24. d~~
25. b

Student: ____________________ File Code: 37.10.01.00.C1-2(B)

Date: ____________________ Date Published: 6-10-77

UNIT POST TEST: TIRE BALANCING (B)

37.10.01.01

1. "Wheel shimmy":

   a. cannot be removed by dynamic balancing.
   b. is caused by worn front-end components.
   c. can be removed with static balancing.
   d. causes greater wear on the front-end parts.

2. A properly balanced tire is:

   a. static balanced.
   b. static and dynamic balanced.
   c. dynamic balanced.
   d. shimmy balanced.

3. Dynamic balance can eliminate:

   a. wheel skip.
   b. wheel tramp.
   c. wheel shimmy.
   d. wheel cupping.

4. When a tire is in proper static balance, the weight mass:

   a. will be evenly distributed around the center of the drum.
   b. is in the same plane as the center of the wheel.
   c. will be evenly distributed around the axis of rotation.
   d. is in the same plane as the axis of rotation.

5. Tires must run reasonably true to prevent:

   a. vibrations and unbalance.
   b. excessive wheel weight.
   c. wearing out the idler/arm.
   d. tire blowout.

37.10.01.02

6. To divide a needed 3/4 ounce weight on a balanced tire in order to split the weights, the mechanic would use:

   a. a 3/4 weight cut in half.
   b. 1/2 and 1/4 ounce weights.
   c. two 3/8 ounce weights.
   d. (cannot be split).

37.10.01.02 (continued)

7. Common wheel weights are available in sizes of:

   a. 1/8 oz.
   b. 1/4 oz.
   c. 1/3 oz.
   d. 1/16 oz.

8. To test a newly balanced tire for accuracy, the mechanic can:

   a. test drive the car.
   b. place the tire back on the balancer.
   c. mark the position of the weights, remove them and rebalance to see if they rebalance themselves as before.
   d. have someone else rebalance the tire after the weights were marked and removed.

9. After the weights are positioned properly, they must also be:

   a. split up so half of the weight is on the direct opposite side.
   b. hammered into place exactly where they are.
   c. matched with the same amount of weight to be placed on the opposite side.
   d. divided into smaller weights before being installed.

37.10.01.03

10. Excessively edge-cupped tires:

    a. can be exchanged from side to side and balanced to save the tire.
    b. should be discarded.
    c. should be placed on the rear and carefully balanced to save the tire.
    d. can be stopped by shock replacement.

11. Before attaching the wheel balancer equipment, the wheel should be checked:

    a. for improper tire size.
    b. for wheel out-of-alignment.
    c. loose wheel bearings.
    d. none of the above.

12. When the spin balancer has indicated the correct needed weight, the mechanic should:

    a. place the weight on the inside of the wheel.
    b. split the weight in half for both sides of the wheel.
    c. place the weight on the outside of the wheel.
    d. add the same amount of registered weight to the inside.

13. The speed of non posi-traction or non no-spin rear end at the speedometer would be approximately:

    a. 70 mph.
    b. 50 mph.
    c. 35 mph.
    d. 25 mph.

37.10.02.03 (continued)

14. To raise the wheel off the floor for spinning, the jack should be placed beneath the car on the:

    a. floor pan.
    b. bumper.
    c. lower control arm.
    d. frame side.

37.10.02.04

15. The cotter key ends should:

    a. not protrude outside the lock nut.
    b. clear all moving parts.
    c. both be bent out and over the spindle end.
    d. be hammered flat to insure a tight fit.

16. Desired roller bearing end play is from:

    a. .0001 to .0003
    b. .050 to .001
    c. .01 to .03
    d. .001 to .003

17. Bearing grease applied to an oily bearing:

    a. insures that the bearing is well lubricated.
    b. will not adhere.
    c. allows time for the grease to work in and around the bearing.
    d. will cause the grease to stick heavily to the bearing cup.

18. Wheel bearings:

    a. should never be spun with air pressure while drying.
    b. should not be removed with a soft steel drift.
    c. should never be oversoaked in solvent.
    d. should be dried with a clean cotton rag.

19. Front wheel bearings are of two types:

    a. bushing and roller.
    b. needle and ball.
    c. ball and tapered roller.
    d. tapered roller and non-tapered roller.

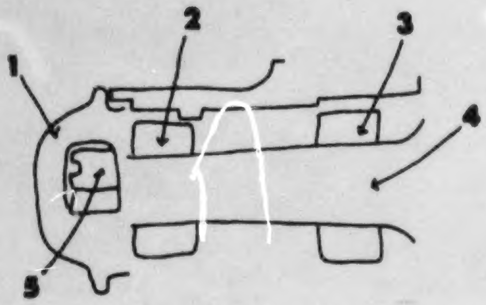
UNIT POST TEST ANSWER KEY: TIRE BALANCING (B)

1. D
2. B
3. C
4. C
5. A
6. B
7. B
8. B
9. A
10. C
11. C
12. B
13. C
14. D
15. B
16. D
17. B
18. A
19. C
20. D
21. B
22. D
23. B

37.10.01.05

20. Part #3* is referred to as the:

    a. hub.
    b. outside bearing.
    c. spindle.
    d. inside bearing.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox, 1969, p. 30-13, Fig. 30-36A.)

21. Part #2* is referred to as the:

    a. inside bearing.
    b. outside bearing.
    c. spindle.
    d. hub.

22. Wheel bearings can be packed by a special machine packer or by:

    a. none of the below.
    b. filling the hub and bearings on the spindle.
    c. soaking over night in the grease container.
    d. hand.

37.10.01.06

23. The four main parts of the wheel bearing are:

    a. ball, cup, cone, bearing.
    b. cup, cone, cage, bearing.
    c. cage, roller, cone, bearing.
    d. race, cup, cage, bearing.

Student: ______________ File Code: 37.10.01.00.C1-2 (C)

Date: ______________ Date Published: 10/6/77

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UNIT POST TEST: TIRE BALANCING (C)

37.10.01.01

1. Tires must run reasonably true to prevent:

   a. vibrations and unbalance.
   b. excessive wheel weight.
   c. wearing out the idler/arm.
   d. tire blowout.

2. "Wheel shimmy":

   a. cannot be removed by dynamic balancing.
   b. is caused by worn front-end components.
   c. can be removed with static balancing.
   d. causes greater wear on the front-end parts.

3. A properly balanced tire is:

   a. static balanced.
   b. static and dynamic balanced.
   c. dynamic balanced.
   d. shimmy balanced.

4. When a tire is in proper static balance, the weight mass:

   a. will be evenly distributed around the center of the drum.
   b. is in the same plane as the center of the wheel.
   c. will be evenly distributed around the axis of rotation.
   d. is in the same plane as the axis of rotation.

5. Dynamic balance can eliminate:

   a. wheel skip.
   b. wheel tramp.
   c. wheel shimmy.
   d. wheel cupping.

37.10.01.02

6. To test a newly balanced tire for accuracy, the mechanic can:

   a. test drive the car.
   b. place the tire back on the balancer.
   c. mark the position of the weights, remove them and rebalance to see if they rebalance themselves as before.
   d. have someone else rebalance the tire after the weights were marked and removed.

37.10.01.02 (continued)

7. To divide a needed 3/4 ounce weight on a balanced tire in order to split the weights, the mechanic would use:

   a. a 3/4 weight cut in half.
   b. 1/2 and 1/4 ounce weights.
   c. two 3/8 ounce weights.
   d. (cannot be split).

8. Common wheel weights are available in sizes of:

   a. 1/8 oz.
   b. 1/4 oz.
   c. 1/3 oz.
   d. 1/16 oz.

9. After the weights are positioned properly, they must also be:

   a. split up so half of the weight is on the direct opposite side.
   b. hammered into place exactly where they are.
   c. matched with the same amount of weight to be placed on the opposite side.
   d. divided into smaller weights before being installed.

37.10.01.03

10. To raise the wheel off the floor for spinning, the jack should be placed beneath the car on the:

   a. floor pan.
   b. bumper.
   c. lower control arm.
   d. frame side.

11. Excessively edge-cupped tires:

   a. can be exchanged from side to side and balanced to save the tire.
   b. should be discarded.
   c. should be placed on the rear and carefully balanced to save the tire.
   d. can be stopped by shock replacement.

12. Before attaching the wheel balancer equipment, the wheel should be checked for:

   a. improper tire size.
   b. wheel out-of-alignment.
   c. loose wheel bearings.
   d. none of the above.

13. The speed of non posi-traction or non-so-spin rear end at the speedometer would be approximately:

   a. 70 mph.
   b. 50 mph.
   c. 35 mph.
   d. 25 mph.

37.10.01.03 (continued)

14. When the spin balancer has indicated the correct needed weight, the mechanic should:

    a. place the weight on the inside of the wheel.
    b. split the weight in half for both sides of the wheel.
    c. place the weight on the outside of the wheel.
    d. add the same amount of registered weight to the inside.

37.10.01.04

15. Front wheel bearings are of two types:

    a. bushing and roller.
    b. needle and ball.
    c. ball and tapered roller.
    d. tapered roller and non-tapered roller.

16. Desired roller bearing end play is from:

    a. .0001 to .0003
    b. .050 to .001
    c. .01 to .03
    d. .001 to .003

17. Wheel bearings:

    a. should never be spun with air pressure while drying.
    b. should not be removed with a soft steel drift.
    c. should never be oversoaked in solvent.
    d. should be dried with a clean cotton rag.

18. The cotter key ends should:

    a. not protrude outside the lock nut.
    b. clear all moving parts.
    c. both be bent out and over the spindle end.
    d. be hammered flat to insure a tight fit.

19. Bearing grease applied to an oily bearing:

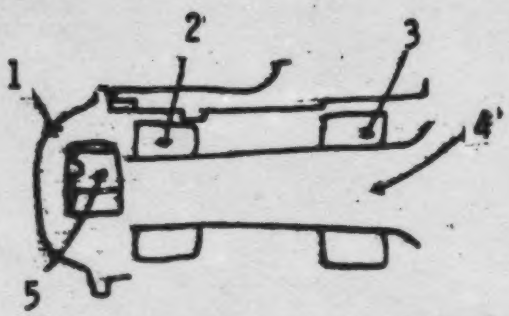
    a. insures that the bearing is well lubricated.
    b. will not adhere.
    c. allows time for the grease to work in and around the bearing.
    d. will cause the grease to stick heavily to the bearing cup.

37.10.01.05

20. Wheel bearings can be packed by a special machine packer or by:

    a. none of the below.
    b. filling the hub and bearings on the spindle.
    c. soaking over night in the grease container.
    d. hand.

37.10.01.05 (continued)



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox, 1969. p. 30-13, Fig. 30-36A.)

21. Part #3* is referred to as the:

    a. hub.
    b. outside bearing.
    c. spindle.
    d. inside bearing.

22. Part #2* is referred to as the:

    a. inside bearing.
    b. outside bearing.
    c. spindle.
    d. hub.

37.10.01.06

23. The four main parts of the wheel bearing are:

    a. ball, cup, cone, bearing.
    b. cup, cone, cage, bearing.
    c. cage, roller, cone, bearing.
    d. race, cup, cage, bearing.

UNIT POST TEST ANSWER KEY: TIRE BALANCING (C)

1. A
2. D
3. B
4. C
5. C
6. B
7. B
8. B
9. A
10. D
11. C
12. C
13. C
14. B
15. C
16. D
17. A
18. B
19. B
20. D
21. D
22. B
23. B

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Student: ____________________ File Code: 37 10.01.00.B1-5

Date: ____________________ Date Published: 3-10-76

Family Pay Number: __________ Sex: M F (Circle 1)

Unit Performance Test: Tire Balancing

OBJECTIVE 1:

Pack front wheel bearings.

OBJECTIVE 2:

Balance tires (static).

OBJECTIVE 3:

Balance tires (spin).

TASK:

The student will be assigned a vehicle on which he must remove, inspect, and repack front wheel bearings and perform static balance on two tires and spin balance on two tires.

ASSIGNMENT:

CONDITIONS:

The student must perform the test using only those materials provided for the test and must perform the test in the auto shop.

RESOURCES:

Bubble Balance
Hunter Spin Balancer
Wheel Weights
Torque Wrench
Wheel Bearing Grease
Jack Stands
Jack
Service Manual
Parts and Labor Guide
Cotter Keys
Combination Ignition Wrench Set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler Gauge -- .002 through .025"
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet -- 3" and 6" extensions -- 6" flex handle
Ball Peen Hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch -- 3/16" Solid
Gasket Scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: ____________________ **File Code:** 37.10.01.00.B1-5

Date: ____________________ **Date Published:** 3-10-76

Family Pay Number: __________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION	
	Met	Not Met
Objective 1:		
1. Remove and inspect front wheel bearings.		
Criterion: Remove hubs without damage and compare wheel		
bearings to manufacturer's specifications.		
2. Pack and replace bearings and front hubs.		
Criterion: Must meet manufacturer's specifications.		
Objective 2:		
3. Perform static balance on two tires.		
Criterion: Must be in balance when road tested.		
Objective 3:		
4. Spin balance two tires.		
Criterion: Must be in balance on road test.		
5. Road test for correct balance.		
Criterion: No noticeable vibration from tires.		

(Checklist continued)

	CRITERION Met	 Not Met
6. Must perform test in allotted time.		
Criterion: Must meet flat rate on assigned vehicle.		
The student must satisfactorily complete 5 out of 6 line items		
to pass this test.		

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Mountain-Plains Education & Economic Development Program, Inc.

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Learning Experience Guide

UNIT: MANUAL STEERING GEARS

RATIONALE:

The fundamentals and techniques in this unit will enable you to diagnose, adjust and overhaul manual steering gears.

PREREQUISITES:

Math Skills at Level F
Communication Skills at Level F

OBJECTIVES:

Recognize the components and proper operation of steering gears. Adjust and overhaul steering gears.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.

Equipment

Automobile with manual steering
Bench vise
Fender covers
Gearbox repair parts
Gearbox lube
Tools, Basic Hand:

- Chisel and Punch Set
  - 5/32" Pin Punch
  - 3/16" Solid

- Gauge, feeler (.002" - .025")

- Hammer, ball peen
- Hammer, plastic tip
- Handle, speed
- Hex Key Set

- Pliers, diagonal cutting
- Pliers, needle nose

Principal Author(s): C. Schramm/W. Osland

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
  extension (3")
  ratchet

Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet

Socket, spark plug
  extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This unit consists of three Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(9) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Manual Steering Gears
.02 Adjusting Manual Steering
.03 Overhauling Manual Steering Gears

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: ______________________ File Code: 37.10.02.01.B1-2
37.10.02.02.B1-2
37.10.02.03.B1-2

Date: ______________________ Date Published: 3/11/76

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UNIT LAP PRETEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS

37.10.02.01.

1. The pitman shaft operates in:

   a. bushings or needle bearings.
   b. a brass shaft.
   c. a cross shaft.
   d. the worm shafts housing.

2. The function of the ball or roller bearings for the worm gear shaft is to:

   a. remove end and side play in the worm.
   b. engage the worm gear to the end of the steering shaft.
   c. let the worm gear slide freely within the housing.
   d. save wear on the pitman bushings.

3. A function of seals is to:

   a. prevent the escape of lubricant.
   b. hold the steering shaft in the housing.
   c. eliminate wear on the worm.
   d. eliminate wear on the steering column.

4. To control the clearance of the worm and pitman shaft you would:

   a. tighten the spindal arm.
   b. use more shims or bushings.
   c. tighten the ball nut.
   d. set the adjustment screw.

5. The purpose of the cast housing in a manual steering gearbox is:

   a. to surround and hold all parts in alignment.
   b. to hold the ball joints in position.
   c. designed to reduce the steering wheel turning effort.
   d. to hold the spool valve in a neutral position.

37.10.02.02.

6. Steering gearbox fluid changes:

   a. can only be done during gearbox overhauls.
   b. should be periodical.
   c. are necessary at every 30,000 miles.
   d. are not necessary if not contaminated.

7. During worm bearing preload adjustment:

   a. remove the pitman arm from the pitman shaft.
   b. the pitman arm must be moved to full left turn.
   c. the pitman arm must be moved to full right turn.
   d. the pitman arm must be centered.

37.10.02.03.

8. The pitman shaft and sector, ball and nut teeth and worm should be inspected with a(n):

   a. bright light.
   b. alignment block.
   c. crack detector.
   d. magnifying glass.

9. Installation of the recirculating balls can be helped with the use of:

   a. magnets.
   b. adhesive glue.
   c. ball guides.
   d. heavy grease.

10. What should be done with each internal part as it is installed?

    a. compared to old replaced parts.
    b. polished.
    c. checked for fit.
    d. lubricated.

UNIT LAP PRETEST ANSWER KEY: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS

LAP .01

1. a
2. a
3. a
4. d
5. a

LAP .02

6. d
7. d

LAP .03

8. c
9. d
10. d

File Code: 37.10.02.01.B1-0

Date Published: 3/10/76

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Fundamentals of Manual Steering Gears

OBJECTIVE:

Recognize the components and proper operation of a manual steering gear box.

EVALUATION PROCEDURE:

Score 80% correct on LAP study questions.
Take the Unit/LAP Post test after completing LAP 37.10.02.03. [illegible]

RESOURCES:

Auto Mechanic Fundamentals, Stockel, Goodheart-Willcox, Inc., 1969.

PROCEDURE:

Steps

1. Obtain text copy and secure a quiet place to study.
2. Read from Chapter 17, beginning with "Steering Gearbox" page 320. Read through to "Power Steering" page 326.
3. Study figures 17-25 through 17-31.
4. On separate paper, neatly answer questions 18 through 21.
5. Give answer sheet to instructor.
6. Return text to shelf.
7. Proceed to next LAP.

Principal Author(s): J. Anderson/W. Osland

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File Code: 37.10.02.02.01-0

Date Published: 3/10/76

Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Adjusting Manual Steering

OBJECTIVE:

Use the proper procedure for adjustment of manual steering gears.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Take the Unit/LAP Post test after completing LAP 37.10.02.03.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.
Automobile equipped with manual steering needing adjustment
Fender covers
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

NOTE: Review pages 31-1 through 31-5 in Auto Service and Repair.

1. Place fender covers.
2. Have an assistant move the steering wheel back and forth in free play while you are observing the total movement of the linkage to determine where the free play exists.
   Remember: Not all steering wheel free play can be removed by adjustment of the steering box. Often after the adjustment a worn suspension component must be replaced.
3. Examine steering box to determine what model it is. Find the adjustment procedure for that particular model in the manual steering section of the repair manual.
4. Determine the amount of adjustment needed by following the inspection procedure of the manual.
5. Adjust the manual steering box to meet the manufacturer's specifications allowed for the amount of play.

Principal Author(s): J. Anderson/W. Osland

6. Inspect the fiuld level of the gear box. Correct as necessary.
7. Ask the instructor to evaluate your completed work.
8. Clean and return all tools and equipment.
9. Clean work area.
10. Proceed to next LAP.

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Overhauling Manual Steering Gears

OBJECTIVE:

Use the correct procedure for the overhaul of manual steering gearbox.

EVALUATION PROCEDURE:

The performance of the overhaul to be evaluated by the instructor in accordance with the manufacturer's specifications.
80% correct on Unit/LAP Post test.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.
Automobile equipped with a manual steering gearbox needing an overhaul
Bench-vise
Gearbox lube
Gearbox repair parts
Fender covers
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

NOTE: Review pages 31-5 through 31-7 in Auto Service and Repair.

1. Place fender covers.
2. Work steering wheel back and forth to diagnose the defect.
3. Remove steering gearbox from vehicle. Follow removal procedure for that particular model from the repair manual.
   NOTE: Here it is mandatory that the removal, disassembly, inspection, repair, and assembly procedures are followed very closely to prevent possible damage or loss of parts; also to insure accurate and satisfactory operation of the completed unit. Steering boxes are available in a variety of models, and the designs vary greatly, increasing the need for manual procedures.

Principal Author(s): J. Anderson/W. Osland

4. Drain gear lube from steering box.
5. Place gearbox on clean bench.
6. Disassemble gearbox. Follow disassembly procedure of repair manual. Place parts in the removal sequence to aid reassembly.
7. Examine all parts for wear and damage.
8. Replace worn parts with new replacement parts from repair kit. Refer to repair manual.
9. Reassemble gearbox. Follow reassembly procedure outline in the repair manual. Lubricate all parts during reassembly.
10. Test movement travel of assembled gearbox in a bench-vise to insure satisfactory operation. Correct gear lube level as required.
11. Install gearbox into vehicle. Be sure that gearbox is centered for even steering travel for full left and right turns. Refer to repair manual for centering procedure.
12. Test the gearbox operation by turning the wheels full right and left with front end up on a jack.
13. When completed, ask the instructor to evaluate your work.
14. Clean and return all tools and equipment.
15. Clean work areas.
16. Take and score the LAP test.
17. Upon successful completion, proceed to the next unit.

UNIT LAP POST TEST ANSWER KEY: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS (A)

LAP .01

1. d

2. c

3. d

4. d

5. c

LAP .02

6. b

7. d

8. d

LAP .03

9. d

10. d

Student: ______________________________ File Code: ___ 37.10.02.01.C1-2
37.10.02.02.C1-2 (A)
37.10.02.03.C1-2

Date: ______________________________ Date Published: 3/11/76 ____________

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UNIT LAP POST TEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL (A) STEERING GEARS

37.10.02.01.

1. To control the clearance of the worm and pitman shaft you would:

   a. tighten the spindal arm.
   b. use more shims or bushings.
   c. tighten the ball nut.
   d. set the adjustment screw.

2. In the drawing* at the right, Part #3 is:

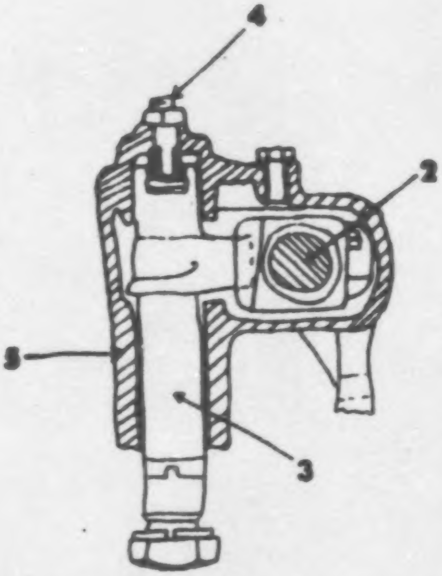
   a. a ball nut.
   b. a worm.
   c. a pitman shaft.
   d. an adjusting screw.

3. In the same drawing, Part #4 is:

   a. a taper pin.
   b. a ball nut.
   c. a worm shaft.
   d. an adjusting screw.

4. In the same drawing, Part #5 is:

   a. a taper pin.
   b. a worm shaft.
   c. a worm.
   d. the housing.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox Company, Inc. 1969, p. 317.)

5. The steering gearbox:

   a. reduces the level of vibration of the vehicle.
   b. resists the revolutions of travel of the pitman arm.
   c. resists the transfer of road shocks to the driver.
   d. produces a more uncomfortable ride for the passengers.

37.10.02.02.

6. Steering gear lubricant should be relatively __________, yet should remain fluid at __________ temperatures.

   a. viscous; high temperatures.
   b. viscous; low temperatures.
   c. thin; low temperatures.
   d. clean; normal temperatures.

7. What two adjustments are performed on the majority of steering boxes?

   a. over-center adjustment and pitman shaft end-play.
   b. pitman shaft travel and end-play.
   c. ball return guide clearance and worm bearing preload.
   d. worm bearing preload and over-center adjustment.

8. Final check of the steering gear adjustment is made with a:

   a. foot-pound torque wrench.
   b. inch-pound torque wrench.
   c. dial indicator.
   d. spring tension gauge.

37.10.02.03.

9. Before disassembly of the manual gearbox:

   a. the adjusting lash screw must be removed.
   b. the pitman arm and pitman shaft should be marked.
   c. the worm gear must be centered.
   d. the housing should be thoroughly cleaned.

10. Installation of the recirculating balls can be helped with the use of:

    a. magnets.
    b. adhesive glue.
    c. ball guides.
    d. heavy grease.

Student: ______________________ File Code: 37.10.02.00.C1-2B
37.10.02.01.C1-2B
37.10.02.02.C1-2B
Date: ______________________ Date Published: 37.10.02.03.C1-2B

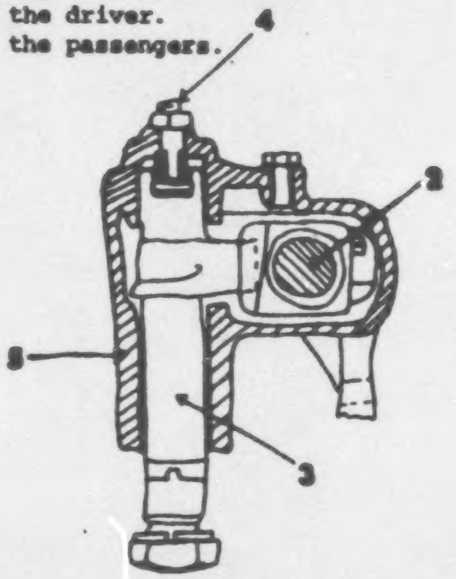
6-16-77

UNIT LAP POST TEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS (B)

37.10.02.01

1. The steering gearbox:

   a. reduces the level of vibration of the vehicle.
   b. resists the revolutions of travel of the pitman arm.
   c. resists the transfer of road shocks to the driver.
   d. produces a more uncomfortable ride for the passengers.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox Company, Inc. 1969, p. 317.)

2. In the same drawing, Part #5 is:

   a. a taper pin.
   b. a worm shaft.
   c. a worm.
   d. the housing.

3. In the same drawing, Part #4 is:

   a. a taper pin.
   b. a ball nut.
   c. a worm shaft.
   d. an adjusting screw.

4. In the drawing* at the right, Part #3 is:

   a. a ball nut.
   b. a worm.
   c. a pitman shaft.
   d. an adjusting screw.

5. To control the clearance of the worm and pitman shaft you would:

   a. tighten the spindal arm.
   b. use more shims or bushings..
   c. tighten the ball nut.
   d. set the adjustment screw.

37.10.02.02

6. Final check of the steering gear adjustment is made with a:

   a. foot-pound torque wrench.
   b. inch-pound torque wrench.
   c. dial indicator.
   d. spring tension gauge.

37.10.02.02

7. What two adjustments are performed on the majority of steering boxes?

   a. over-center adjustment and pitman shaft end-play.
   b. pitman shaft travel and end-play.
   c. ball return guide clearance and worm bearing preload.
   d. worm bearing preload and over-center adjustment.

8. Steering gear lubricant should be relatively ___________, yet should remain fluid at ___________ temperatures.

   a. viscous; high temperatures.
   b. viscous; low temperatures.
   c. thin; low temperatures.
   d. clean; normal temperatures.

37.10.02.03

9. Installation of the recirculating balls can be helped with the use of:

   a. magnets.
   b. adhesive glue.
   c. ball guides.
   d. heavy grease.

10. Before disassembly of the manual gearbox:

   a. the adjusting lash screw must be removed.
   b. the pitman arm and pitman shaft should be marked.
   c. the worm gear must be centered.
   d. the housing should be thoroughly cleaned.

UNIT LAP POST TEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS (B)

1. C
2. D
3. D
4. C
5. D
6. D
7. D
8. B
9. D
10. D

Student: ____________________ File Code: 37.10.02.00.C1-2C
37.10.02.01.C1-2C
~~37.10.02.02.C1-2C~~
37.10.02.03.C1-2C

Date: ____________________ Date Published: 6-16-77

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UNIT LAP POST TEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS (C)

37.10.02.01

1. To control the clearance of the worm and pitman shaft you would:

   a. tighten the spindal arm.
   b. use more shims or bushings.
   c. tighten the ball nut.
   d. set the adjustment screw.

2. In the same drawing, Part #4 is:

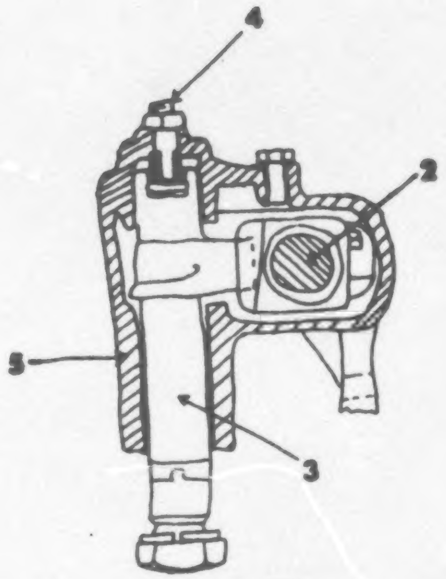
   a. a taper pin.
   b. a ball nut.
   c. a worm shaft.
   d. an adjusting screw.

3. In the same drawing, Part #5 is:

   a. a taper pin.
   b. a worm shaft.
   c. a worm.
   d. the housing.

4. In the drawing* at the right, Part #3 is:

   a. a ball nut.
   b. a worm.
   c. a pitman shaft.
   d. an adjusting screw.



*(Adapted from Auto Service and Repair, Stockel, Goodheart-Willcox Company, Inc. 1969, p. 317.)

5. The steering gearbox:

   a. reduces the level of vibration of the vehicle.
   b. resists the revolutions of travel of the pitman arm.
   c. resists the transfer of road shocks to the driver.
   d. produces a more uncomfortable ride for the passengers.

37.10.02.02

6. Steering gear lubricant should be relatively __________, yet should remain fluid at ______________ temperatures.

   a. viscous; high temperatures.
   b. viscous; low temperatures.
   c. thin; low temperatures.
   d. clean; normal temperatures.

37.10.02.02

7. Final check of the steering gear adjustment is made with a:

   a. foot-pound torque wrench.
   b. inch-pound torque wrench.
   c. dial indicator.
   d. spring tension gauge.

8. What two adjustments are performed on the majority of steering boxes?

   a. over-center adjustment and pitman shaft end-play.
   b. pitman shaft travel and end-play.
   c. ball return guide clearance and worm bearing preload.
   d. worm bearing preload and over-center adjustment.

37.10.02.03

9. Before disassembly of the manual gearbox:

   a. the adjusting lash screw must be removed.
   b. the pitman arm and pitman shaft should be marked.
   c. the worm gear must be centered.
   d. the housing should be thoroughly cleaned.

10. Installation of the recirculating balls can be helped with the use of:

    a. magnets.
    b. adhesive glue.
    c. ball guides.
    d. heavy grease.

UNIT LAP POST TEST: FUNDAMENTALS OF ADJUSTING AND OVERHAULING MANUAL STEERING GEARS (C)

1. D
2. D
3. D
4. C
5. C
6. B
7. D
8. D
9. D
10. D

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Student: ______________________ File Code: 37.10.02.00.B1-5

Date: ______________________ Date Published: 3/10/76

Family Pay Number: __________ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: STEERING GEARS

OBJECTIVE 1:

Overhaul manual steering gear.

OBJECTIVE 2:

Adjust manual steering gear.

TASK:

The student will be assigned a vehicle on which he must overhaul a manual steering gear box and adjust end play and high point on the gears.

ASSIGNMENT:

CONDITIONS:

The student must perform the test using only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

Repair manual
Parts and Time Guide
Repair Parts if Needed
Jack
Jack Stands
Fender Covers
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

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Student: ________________ File Code: 37.10.02.00.B1-5

Date: ________________ Date Published: 3/10/76

Family Pay Number: ________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION	
	Met	Not Met
Objective 1:		
1. Remove steering gear box.		
Criterion: Does not damage car or gear box.		
2. Disassembles and inspects gear box components.		
Criterion: Follows service manual procedure and		
compares parts to manufacturer's		
specifications.		
3. Assembles steering gear box.		
Criterion: Must meet manufacturer's specifications.		
Objective 2:		
4. Adjusts end play.		
Criterion: Must meet manufacturer's specifications.		
5. Adjusts high point or through point.		
Criterion: Must meet manufacturer's specifications.		
6. Completes test in alloted time for assigned vehicle.		

	CRITERION	
	Met	Not Met
Criterion: Must meet flat rate for assigned vehicle.		
The student must complete 5 out of 6 line items to achieve		
an overall score of satisfactory.		

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Learning Experience Guide

UNIT: POWER STEERING

RATIONALE:

The fundamentals and techniques in this unit will enable one to diagnose and overhaul power steering components.

PREREQUISITES:

Math Skills at Level F
Communication Skills at Level F

OBJECTIVES:

Recognize the components and proper operation of power steering. Use the proper procedure for overhaul of power steering components.

RESOURCES:

Printed Materials

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.

Equipment

Automobile with power steering
Drain pan
Fender covers
Power steering fluid
Replacement parts as needed
Tools, Basic Hand:

Chisel and Punch Set
  5/32" Pin Punch
  3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Principal Author(s): C. Schramm/W. Osland

Resources: Equipment: Continued

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
  extension (3")
  ratchet

Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet

Socket, spark plug
  extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This unit consists of four Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Power Steering
.02 Overhaul of Power Steering Pumps
.03 Overhaul of Power Steering Control Units
.04 Overhaul of Power Steering Cylinders

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the critieria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Recofd (SPR).

Student: ______________________ **File Code:** 37.10.03.00.B1-2

Date: ______________________ **Date Published:** 3/11/76

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UNIT PRETEST: POWER STEERING

37.10.03.01.

1. A hydraulic pump power steering unit is generally operated by:

   a. a belt driven by the engine.
   b. a power piston.
   c. an electric motor running off of the battery.
   d. a universal shaft, generally six (6) feet long.

2. What is meant by a self-contained power steering unit?

   a. it is the same as the slipper vane unit and roller vane unit.
   b. the power cylinder and control valve are in separate units.
   c. the oil reservoir is mounted directly on top of the power steering unit.
   d. the control valve mechanism, power piston, and gears are in an integral unit.

3. Oil, in a power steering unit under pressure from the pumps, enters the valve body by way of:

   a. the back pressure valve.
   b. the inlet passage.
   c. the lower cylinder head.
   d. the power chamber.

4. When no pressure is being applied to the steering wheel, the spool valve is:

   a. in a neutral position.
   b. straight up and down.
   c. compressed or engaged by the pivot lever.
   d. vibrating profusely along with the pivot lever.

5. The center thrust bearing can move up or down with the worm shaft, but not:

   a. when there is an excess of lubricating oil.
   b. while under pressure.
   c. while having pressure on it and the spool valve is in the left position.
   d. around with it.

37.10.03.02.

6. The pump pulley should be removed with a:

a. puller.
b. press.
c. plastic hammer.
d. slide hammer.

7. To replace a leaking drive shaft seal:

a. the pulley can be removed, pry the seal out and install a new one without further disassembly.
b. the entire unit must be removed and disassembled.
c. it is best to overhaul the entire pump.
d. the pump should be fully tested for additional leaks.

37.10.03.03.

8. A power steering control valve regulates oil under pressure to:

a. the worm.
b. the reservoir.
c. the right or left of the rack-piston nut.
d. the sector shaft.

37.10.03.04.

9. When overhauling a power steering cylinder, it is important to:

a. know where the reservoir is located.
b. avoid nicking parts and to keep all parts clean.
c. keep the oil full at all times.
d. have the ball nut connected directly to the power piston.

10. When reinstalling the steering gear, misalignment can:

a. correct itself over a period of time.
b. cause bindings and premature wear.
c. affect the reservoir and pump.
d. affect the steering pump cooler.

UNIT PRETEST ANSWER KEY: POWER STEERING

LAP .01

1. a
2. d
3. b
4. a
5. d

LAP .02

6. a
7. a

LAP .03

8. c

LAP .04

9. b
10. b

File Code: 37.10.03.01.B1-0

Date Published: 3/10/76

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Learning Activity Package

Student:

Date:

PERFORMANCE ACTIVITY: Fundamentals of Power Steering

OBJECTIVE:

Recognize components and proper operation of the power steering system.

EVALUATION PROCEDURE:

Score 80% correct on LAP study questions.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.

PROCEDURE:

Steps

1. Obtain text copy and secure a quiet place to study.
2. From Chapter 17, beginning with "Power Steering" page 326, read through to "Quiz" page 336.
3. Study figures 17-32 through 17-52.
4. On separate paper, neatly answer questions 22 through 32 on page 336.
5. Give answer sheet to instructor for evaluation.
6. Return text to shelf.
7. Take and score the LAP test.
8. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osiand

Student: ______________________ File Code: 37.10.03.01.B1-2

Date: ______________________ Date Published: 3/10/76

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LAP TEST: FUNDAMENTALS OF POWER STEERING

1. A power steering unit is designed:
   a. to reduce the steering wheel turning effort.
   b. for women primarily.
   c. for racing when quick turning is needed.
   d. to be used in the more sophisticated cars.

2. The feeling imparted to the steering wheel by the wheels of a car in motion is called:
   a. phantom pressure.
   b. power steering.
   c. turning effort.
   d. road feel.

3. To maintain road feel, power steering systems require:
   a. them to be mounted somewhat loosely.
   b. some wheel effort.
   c. them to be self-contained.
   d. them to have rack and pinion steering gearbox.

4. A hydraulic pump power steering unit is generally operated by:
   a. a belt driven by the engine.
   b. a power piston.
   c. an electric motor running off of the battery.
   d. a universal shaft, generally (6) six feet long.

5. What is meant by a self-contained power steering unit?
   a. it is the same as the slipper vane unit and roller vane unit.
   b. the power cylinder and control valve are in separate units.
   c. the oil reservoir is mounted directly on top of the power steering unit.
   d. the control valve mechanism, power piston, and gears are in an integral unit.

6. Oil, in a power steering unit under pressure from the pump, enters the valve body by way of:
   a. the back pressure valve.
   b. the inlet passage.
   c. the lower cylinder head.
   d. the power chamber.

7. The center thrust bearing can move up or down with the worm shaft, but not:

   a. when there is an excess of lubricating oil.
   b. while under pressure.
   c. while having pressure on it and the spool valve is in the left position.
   d. around with it.

8. If the spool valve is in a neutral position, oil is fed:

   a. to the pitman shaft by the power piston.
   b. nowhere.
   c. only to the steering column connection.
   d. to both sides of the power piston and to the reaction rings.

9. Oil leakage in the power steering pump is prevented by:

   a. neoprene rubber rings that ride in grooves.
   b. a brass bushing.
   c. a collar.
   d. a back pressure valve.

10. The worm shaft must be connected to the steering shaft to allow for:

    a. movement on the end of the pitman shaft.
    b. play in the steering shaft.
    c. play in the steering column.
    d. movement on the end of the worm shaft.

LAP TEST ANSWER KEY: FUNDAMENTALS OF POWER STEERING

LAP .01

1. a
2. d
3. b
4. a
5. d
6. b
7. d
8. d
9. a
10. d

File Code: 37.10.03.02.B1-0

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Learning Activity Package

Student: ____________

Date: ____________

PERFORMANCE ACTIVITY: Overhaul of Power Steering Pumps

OBJECTIVE:

Use the proper procedure for overhaul of power steering pumps.

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after completing LAP 37.10.03.04.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Automobile with power steering pump
Fender covers
Power steering fluid
Replacement parts as needed
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

NOTE: Review pages 31-15 through 31-17 in Auto Service and Repair.

1. Place fender covers.
2. Remove power steering pumps. Follow removal procedure of repair manual.
3. Drain remaining fluid out of pumps.
4. Disassemble the pump. Refer to disassembly procedure of manual. Lay all parts out in removal order on a clean area of the work bench.
5. Inspect all parts for wear and damage.
6. Replace all damaged parts. Replace all worn parts with the new replacement parts.
7. Lubricate all new parts and reassemble the pump. Refer to assembly procedure of manual.
8. Re-install pump in vehicle.

Principal Author(s): J. Anderson/W. Osland

9. Fill fluid level with power steering fluid.
10. Test power steering by turning the wheels full right and left for positive assistance.
11. When satisfactorily operational, ask the instructor to inspect the completed work for evaluation.
12. Clean and return all tools and equipment.
13. Clean work areas.
14. Proceed to next LAP.

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Overhaul of Power Steering Control Units

OBJECTIVE:

Use the proper procedure for the overhaul of power steering control unit.

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after completing LAP 37.10.03.04.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Automobile with power steering control unit
Drain pan
Fender covers
Power steering fluid
Replacement parts as needed
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

NOTE: Review pages 31-7 through 31-15 in Auto Service and Repair.

1. Place fender covers.
2. Examine power steering fluid level.
3. Diagnose power steering problem.
   NOTE: Prediagnosis aids the inspection of the disassembled unit in locating the defective part. Operate the steering full left and right while listening and feeling for noticeable problems. Refer to manual for diagnosis procedure. Record diagnosis results on work order.
4. Place drain pan below control unit to catch leaking fluid during removal from vehicle.
5. Remove control unit from vehicle. Refer to removal procedure of manual.

Principal Author(s): J. Anderson/W. Osland

6. Drain remaining fluid from control unit.
7. Disassemble control unit on a clean bench. Follow closely the disassembly procedure outlined in the manual. CAUTION: Extreme care must be taken to insure correct reassembly of control unit. Place all parts in the removal sequence on the bench.
8. Clean and inspect all parts for wear and damage.
9. Replace the worn parts with the new replacement parts.
10. Lubricate the parts with power steering fluid and reassemble. Follow reassembly procedure of repair manual closely.
11. Remount control unit in the vehicle. Refer to manual for proper steering centering procedure.
12. Correct fluid level with power steering fluid.
13. Operate steering full left and right turns for positive assistance and assurance of repair of the problem. Check for leaks.
14. Ask the instructor to evaluate the completed work.
15. Clean work areas.
16. Clean and return all tools and equipment.
17. Proceed to next LAP.

File Code: 37.10.03.04.B1-0

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Overhaul of Power Steering Cylinders

OBJECTIVE:

Overhaul a power steering cylinder.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Repair Manual for make and model of car assigned

Automobile with power steering cylinder
Drain pan
Fender covers
Power steering fluid
Replacement parts as needed
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

Steps

1. Place fender covers.
2. Correct fluid level if needed.
3. Test operate the power steering to diagnose problem of the defective steering. Refer to diagnose procedure of manual. Record results on work order.
4. Remove cylinder from vehicle. Refer to removal procedure of the repair manual. Use drain pan to catch leaking fluid.
5. Clean excessive dirt and grease from the cylinder exterior.
6. Disassemble cylinder on a clean bench. Refer to the manual for disassembly procedure. Keep all parts in order of removal.
7. Clean and inspect all parts for damage and wear.
8. Replace worn parts with the new replacement parts.

Principal Author(s): J. Anderson/W. Osland

9. Lubricate all the parts with power steering fluid and reassemble. Refer to assembly procedure of manual.
10. Install cylinder on vehicle.
11. Correct fluid level.
12. Test operate power steering for satisfactory operation. Check for any signs of leakage.
13. Ask the instructor to evaluate the completed work.
14. Clean and return all tools and equipment.
15. Clean work areas.
16. Take and score the LAP test.

Student: ____________________ File Code: 37.10.03.02.B1-2
37.10.03.03.B1-2
37.10.03.04.B1-2

Date: ____________________ Date Published: 3/10/76

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LAP TEST: OVERHAULING POWER STEERING PUMPS, CONTROL UNITS AND CYLINDERS

37.10.03.02.

1. To replace a leaking drive shaft seal:

   a. the pulley can be removed, pry the seal out and install a new one without further disassembly.
   b. the entire unit must be removed and disassembled.
   c. it is best to overhaul the entire pump.
   d. the pump should be fully tested for additional leaks.

2. Over-tightening of the pump belt will usually result in:

   a. premature failure of the pump.
   b. premature failure of the shaft bearing.
   c. premature failure of the belt.
   d. misalignment of the pump pulley.

3. The majority of power steering pumps are:

   a. not equipped with any pressure control device.
   b. partial flow.
   c. pressure-relieved when the wheels are straight ahead.
   d. constant pressure flow.

37.10.03.03.

4. You should record diagnosis results on:

   a. the power steering unit.
   b. top of the air cleaner so you won't forget.
   c. nothing, it is not necessary.
   d. a work order.

5. Prior to reassembly of the power steering unit, you should:

   a. lubricate the parts with 30 weight oil.
   b. lubricate the parts with a light grease.
   c. clean them thoroughly and put them together dry.
   d. lubricate the parts with power steering fluid.

6. To completely drain a power steering control unit you could:

   a. turn the housing in every angle and it will drip completely dry.
   b. put an air hose on the end of the pressure port seat.
   c. remove the hoses from the pressure port seat and let it drain overnight.
   d. drain it by turning the stub shaft on the rack piston several times.

37.10.03.04.

7. When overhauling a power steering cylinder, it is important to:

   a. know where the reservoir is located.
   b. avoid nicking parts and to keep all parts clean.
   c. keep the oil full at all times.
   d. have the ball nut connected directly to the power piston.

8. When reinstalling the steering gear, check for proper alignment with the:

   a. worm.
   b. steering shaft.
   c. shift rods.
   d. shim.

9. When reinstalling the steering gear, misalignment can:

   a. correct itself over a period of time.
   b. cause bindings and premature wear.
   c. affect the reservoir and pump.
   d. affect the steering pump cooler.

10. To admit oil pressure to the power cylinder, the pitman arm:

    a. forces the tie rod to pump the oil into the cylinder.
    b. turns off the shut-off valve.
    c. moves the control valve to the open position.
    d. develops five pounds of back pressure.

LAP TEST ANSWER KEY: OVERHAULING POWER STEERING PUMPS, CONTROL UNITS AND CYLINDERS

LAP .02

1. a
2. b
3. d

LAP .03

4. d
5. d
6. d

LAP .04

7. b
8. b
9. b
10. c

UNIT POST TEST ANSWER KEY: POWER STEERING(A)

LAP .01

1. c
2. c or b
3. a
4. d
5. c

LAP .02

6. b
7. c

LAP .03

8. c
9. c

LAP .04

10. a

37.10.03.02.

6. The slipper pump uses what to keep the slippers out against the wall?

   a. oil pressure.
   b. springs.
   c. centrifugal force.
   d. balanced weights.

7. A vibrating flow control valve in the pump usually indicates:

   a. overfilled with fluid.
   b. sticking valve.
   c. low on fluid in the reservoir.
   d. leaking pressure within the pump.

37.10.03.03.

8. A power steering control valve regulates oil under pressure to:

   a. the worm.
   b. the reservoir.
   c. the right or left of the rack-piston nut.
   d. the sector shaft.

9. When adjusting the worm to rack-piston preload, you receive a mild preload from:

   a. the damper seal.
   b. the reservoir tank.
   c. the worm groove which is ground with a high point in the center.
   d. the pressure port seat.

37.10.03.04.

10. When putting a power steering unit together again, you have how many basic adjustments on an in-line power steering gear?

    a. 3
    b. 5
    c. 2
    d. 4

Student: ______________________ File Code: 37.10.03.00.C1-2B

Date: ______________________ Date Published: 10/6/77

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UNIT POST TEST: POWER STEERING (B)

37.10.03.01

1. In a rotary valve action unit, when the steering wheel is moved to the right, a turning force is applied to the stub shaft and through the pin to the:

   a. pitman shaft.
   b. spool valve.
   c. torsion bar.
   d. check valve.

2. In a self-contained, offset, power steering gear, the additional force offered by the pressurized oil is applied to:

   a. the right turn power chamber only.
   b. the spool valve.
   c. the left turn power chamber only.
   d. the pitman shaft.

3. Oil leakage in the power steering pump is prevented by:

   a. neoprene rubber rings that ride in grooves.
   b. a brass bushing.
   c. a collar.
   d. a back pressure valve.

4. The worm shaft is connected to the steering shaft by a:

   a. brass bushing.
   b. universal joining.
   c. flexible connector.
   d. spool valve.

5. The two forces on the center thrust bearing "fight" against the driver's turning force on the wheel and produce:

   a. a vibration in the front-end which can cause you to lose control of your car.
   b. a hazard when driving.
   c. road feel.
   d. no feel at all if you have a good power steering unit.

37.10.03.02

6. A vibrating flow control valve in the pump usually indicates:

   a. overfilled with fluid.
   b. sticking valve.
   c. low on fluid in the reservoir.
   d. leaking pressure within the pump.

37.10.03.02 (continued)

7. The slipper pump uses what to keep the slippers out against the wall?

   a. oil pressure.
   b. springs.
   c. centrifugal force.
   d. balanced weights.

37.10.03.03

8. When adjusting the worm to rack-piston preload, you receive a milk preload from:

   a. the damper seal.
   b. the reservoir tank.
   c. the worm groove which is ground with a high point in the center.
   d. the pressure port seat.

9. A power steering control valve regulates oil under pressure to:

   a. the worm.
   b. the reservoir.
   c. the right or left of the rack-piston nut.
   d. the sector shaft.

37.10.03.04

10. When putting a power steering unit together again, you have how many basic adjustments on an in-line power steering gear?

   a. 3
   b. 5
   c. 2
   d. 4

UNIT POST TEST ANSWER KEY: POWER STEERING (B)

1. C
2. D
3. A
4. C or B
5. C
6. C
7. B
8. C
9. C
10. A

Student: ______________________ File Code: 37.10.03.00.C1-2(C)

Date: ______________________ Date Published: 6-20-77

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UNIT POST TEST: POWER STEERING(C)

37.10.03.01

1. In a self-contained, offset, power steering gear, the additional force offered by the pressurized oil is applied to:

   a. the right turn power chamber only.
   b. the spool valve.
   c. the left turn power chamber only.
   d. the pitman shaft.

2. Oil leakage in the power steering pump is prevented by:

   a. neoprene rubber rings that ride in grooves.
   b. a brass bushing.
   c. a collar.
   d. a back pressure valve.

3. In a rotary valve action unit, when the steering wheel is moved to the right, a turning force is applied to the stub shaft and through the pin to the:

   a. pitman shaft.
   b. spool valve.
   c. torsion bar.
   d. check valve.

4. The two forces on the center thrust bearing "fight" against the driver's turning force on the wheel and produce:

   a. a vibration in the front-end which can cause you to lose control of your car.
   b. a hazard when driving.
   c. road feel.
   d. no feel at all if you have a good power steering unit.

5. The worm shaft is connected to the steering shaft by a:

   a. brass bushing.
   b. universal joint.
   c. flexible connector.
   d. spool valve.

37.10.03.02

6. The slipper pump uses what to keep the slippers out against the wall?

   a. oil pressure.
   b. springs.
   c. centrifugal force.
   d. balanced weights.

37.10.03.02 (continued)

7. A vibrating flow control valve in the pump usually indicates:

   a. overfilled with fluid.
   b. sticking valve.
   c. low on fluid in the reservoir.
   d. leaking pressure within the pump.

37.10.03.03

8. A power steering control valve regulates oil under pressure to:

   a. the worm.
   b. the reservoir.
   c. the right or left of the rack-piston nut.
   d. the sector shaft.

9. When adjusting the worm to rack-piston preload, you receive a milk preload from:

   a. the damper seal.
   b. the reservoir tank.
   c. the worm groove which is ground with a high point in the center.
   d. the pressure port seat.

37.10.03.04

10. When putting a power steering unit together again, you have how many basic adjustments on an in-line power steering gear?

    a. 3
    b. 5
    c. 2
    d. 4

Student: ______________________ File Code: 37.10.03.00.C1-2(C)

Date: ______________________ Date Published: 6-20-77

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UNIT POST TEST: POWER STEERING(C)

37.10.03.01

1. In a self-contained, offset, power steering gear, the additional force offered by the pressurized oil is applied to:
   - a. the right turn power chamber only.
   - b. the spool valve.
   - c. the left turn power chamber only.
   - d. the pitman shaft.

2. Oil leakage in the power steering pump is prevented by:
   - a. neoprene rubber rings that ride in grooves.
   - b. a brass bushing.
   - c. a collar.
   - d. a back pressure valve.

3. In a rotary valve action unit, when the steering wheel is moved to the right, a turning force is applied to the stub shaft and through the pin to the:
   - a. pitman shaft.
   - b. spool valve.
   - c. torsion bar.
   - d. check valve.

4. The two forces on the center thrust bearing "fight" against the driver's turning force on the wheel and produce:
   - a. a vibration in the front-end which can cause you to lose control of your car.
   - b. a hazard when driving.
   - c. road feel.
   - d. no feel at all if you have a good power steering unit.

5. The worm shaft is connected to the steering shaft by a:
   - a. brass bushing.
   - b. universal joint.
   - c. flexible connector.
   - d. spool valve.

37.10.03.02

6. The slipper pump uses what to keep the slippers out against the wall?
   - a. oil pressure.
   - b. springs.
   - c. centrifugal force.
   - d. balanced weights.

37.10.03.02 (continued)

7. A vibrating flow control valve in the pump usually indicates:
    a. overfilled with fluid.
    b. sticking valve.
    c. low on fluid in the reservoir.
    d. leaking pressure within the pump.

37.10.03.03

8. A power steering control valve regulates oil under pressure to:
    a. the worm.
    b. the reservoir.
    c. the right or left of the rack-piston nut.
    d. the sector shaft.

9. When adjusting the worm to rack-piston preload, you receive a milk preload from:
    a. the damper seal.
    b. the reservoir tank.
    c. the worm groove which is ground with a high point in the center.
    d. the pressure port seat.

37.10.03.04

10. When putting a power steering unit together again, you have how many basic adjustments on an in-line power steering gear?
    a. 3
    b. 5
    c. 2
    d. 4

UNIT POST TEST ANSWER KEY: POWER STEERING (C)

1. D
2. A
3. C
4. C
5. C or B
6. B
7. C
8. C
9. C
10. A

Student: ______________________ File Code: 37.10.03.00.B1-5

Date: ______________________ Date Published: 3/10/76

Family Pay Number: __________ Sex: M F (Circle 1)

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UNIT PERFORMANCE TEST: POWER STEERING

OBJECTIVE 1:

Overhaul power steering units.

TASK:

The student will be assigned a vehicle on which he must overhaul the power steering pump and control units.

ASSIGNMENT:

CONDITIONS:

The student must perform the test using only those materials provided for the test and complete the test in the auto shop.

RESOURCES:

Service Manual
Parts and Time Manual
Parts if Needed
Snap Ring Pliers
Hoses if needed
Power Steering Fluid
Overhaul Gasket Set

RESOURCES: (Cont.)

Jack
Jack Stands
Fender Covers
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

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Student: ______________________ File Code: 37.10.03.00.B1-5

Date: ______________________ Date Published: 3/10/76

Family Pay Number: __________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION	
	Met	Not Met
Objective 1:		
1. Remove power steering pump.		
Criterion: Does not damage pump or vehicle.		
2. Disassemble and inspect pump components.		
Criterion: Compares parts to manufacturer's specifications.		
3. Assembles pump.		
Criterion: Must follow service manual procedures and		
meet manufacturer's specifications.		
4. Remove power steering control unit.		
Criterion: Does not damage unit or vehicle.		
5. Disassembles and inspects power steering control		
unit.		
Criterion: Compares parts to manufacturer's		
specifications.		
6. Assembles and installs power steering control unit.		

(Checklist continued)

	CRITERION	
	Met	Not Met
Criterion: Must meet manufacturer's specifications.		
7. Tests power steering system.		
Criterion: Must meet manufacturer's specifications.		
8. Must complete test in allotted time.		
Criterion: Must meet flat rate on assigned vehicle.		
Student must satisfactorily complete 7 out of 8 line items		
to achieve an overall score of satisfactory.		

File Code: 37.10.04.00.B1-1

Date Published: 3/10/76

Mountain-Plains Education &
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Learning Experience Guide

UNIT: FUNDAMENTALS OF SUSPENSION

RATIONALE:

The fundamentals in this unit will familiarize you with the components of front-end suspension and enable you to properly replace front-end components.

PREREQUISITES:

Math Skills at Level E for LAP 1
Math Skills at Level F for LAPs 2-4
Communication Skills at Level E for LAP 1
Communication Skills at Level F for LAPs 2-4

OBJECTIVE:

Recognize the components and proper operation of front-end suspension and the correct procedure for replacement of front-end components. Replace front-end components.

RESOURCES:

Auto Mechanics Fundamentals. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation, 1972 or equivalent.

Automobile needing replacement for: ball joint
control arm bushing
idler arm
tie rod

Cotter key
Creeper
Grease
Jacks (or lift)
Jack stands
Projector
Replacement parts
Special installation tools for ball joints

Principal Author(s): C. Schramm/W. Osland

RESOURCES: Equipment (cont.)

Tools, Basic Hand:

Chisel and Punch Set
  5/32" Pin Punch
  3/16" Solid

Gauge, feeler (.002" - .025")

Hammer, ball peen
Hammer, plastic tip
Handle, speed
Hex Key Set

Pliers, diagonal cutting
Pliers, needle nose

Scraper, gasket
Screwdriver, standard (Set)
Screwdriver, phillips (Set)
Screw starter

Socket Set (3/8" drive)
  extension (3")
  ratchet

Socket Set (1/4" drive)
  extension (3")
  handle (6" flex)
  ratchet

Socket, spark plug
  extension (6")

Wrench, combination (Set)
Wrench, combination ignition (Set)

GENERAL INSTRUCTIONS:

This unit consists of five Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.
(8) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(9) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Fundamentals of Front-End Suspension
.02 Replacing Ball Joints
.03 Replacement of Tie-Rod Ends
.04 Replacement of Idler Arms
.05 Replacement of Control Arm Bushings

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: ______________________ File Code: 37.10.04.00.B1-2

Date: ______________________ Date Published: 3/11/76

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UNIT PRETEST: FUNDAMENTALS OF SUSPENSION

37.10.04.01.

1. The integral type frame is constructed as a:

   a. part of the body.
   b. separate unit from the body.
   c. part of the main suspension.
   d. separate steel frame.

2. Spring oscillation is:

   a. the forward and backward movement of the springs caused by the wheel hitting a bump.
   b. the up and down movement of the spring caused by the wheel hitting a bump.
   c. the upward movement of the spring caused by the wheel hitting a bump.
   d. the downward motion of the spring caused by the wheel hitting a bump.

3. Independent front suspension:

   a. lets each front wheel turn independently.
   b. allows the car to turn freely on corners.
   c. allows either front wheel to move up and down independently.
   d. allows the front wheels to move up and down at the same time.

4. The use of ball joints on the independent front suspension replaces the use of:

   a. rubber bushing and gromets.
   b. spindle and wheel bearings.
   c. springs and shackles.
   d. threaded bushings and kingpins.

5. The stabilizer bar is used to:

   a. stabilize lower control arm.
   b. overcome spring oscillations.
   c. overcome unsprung weight.
   d. overcome the tendency for car's body to lean on corners.

6. When lubricating the suspension system, never grease:

   a. ball joints.
   b. kingpins.
   c. tie rod ends.
   d. rubber gromets and bushings.

37.10.04.01. cont.

7. Positive camber is tipping the tops of the wheels:

   a. in.
   b. out.
   c. back.
   d. forward.

8. When removing coil springs that are under pressure:

   a. lower the complete front-end.
   b. stand clear as the last bolt is loosened.
   c. keep the weight on the spring.
   d. use a coil spring compressor.

9. A long bar of strong steel that is used to support suspension weight is referred to as a:

   a. strut bar.
   b. stabilizer bar.
   c. torsion bar.
   d. tie rod bar.

10. The term used for the weight of all parts of the car that are supported by the suspension system is:

    a. drop-weight.
    b. unsprung weight.
    c. out-of-balance.
    d. sprung weight.

37.10.04.02.

11. To check the ball joint wear effectively:

    a. the wheel bearings must be loose.
    b. the wheel must not be off the floor.
    c. the pressure must be released.
    d. the front shocks must be removed.

12. [illegible]

13. Riveted mounted ball joints are replaced with:

    a. bolts.
    b. new rivets.
    c. welding into place.
    d. screw in ball joints.

37.10.04.02. cont.

14. When lowering the disconnected ball joint arm with a jack, the jack should be:

    a. a quick release hydraulic hand jack.
    b. parallel with the frame.
    c. directly below the spring on the arm.
    d. parallel with the legnth of the suspension arm.

15. After installation of the joint into the spindle:

    a. a lock washer and nut should be quickly installed.
    b. the nut should be hand tightened as much as possible and pinned.
    c. the nut should be torqued.
    d. the joint nut and a lock nut should be installed.

37.10.04.03.

16. Before tie-rod-end removal:

    a. the tie rod should be checked for being bent.
    b. the length of the tie rod should be measured and recorded.
    c. the tie-rod-end should be threaded out of the sleeve.
    d. the steering wheel should be locked into position.

37.10.04.04.

17. The function of the idler arm is to:

    a. support front-end suspension weight.
    b. move the steering linkage to turn the wheels.
    c. carry the steering linkage movement.
    d. move the pitman arm in the direction necessary to turn.

18.

37.10.04.05.

19. When one arm bushing is worn:

    a. both bushings of that arm should be replaced.
    b. it should be replaced only to save time and expense.
    c. replace the one and measure the other for amount of extended life.
    d. the entire control arm should be replaced.

20.

UNIT/LAP PRETEST ANSWER KEY: FUNDAMENTALS OF SUSPENSION

LAP .01

1. a
2. b
3. c
4. d
5. d
6. d
7. b
8. d
9. c
10. d

LAP .02

11. c
12. d
13. a
14. d
15. c

LAP .03

16. b

LAP .04

17. c
18. d

LAP .05

19. a
20. b

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Mountain-Plains Education &
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Glasgow AFB, Montana 59231

Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Fundamentals of Front-End Suspension

OBJECTIVE:

Recognize the operation of each component of a suspension system.

EVALUATION PROCEDURE:

80% correct on LAP study questions.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Auto Mechanics Fundamentals, Stockel.
Auto Service and Repair, Stockel.

PROCEDURE:

1. Do the following assignments using Auto Mechanics Fundamentals:
   a. Read Chapter 15, "Frames, Bodies, Springs, Suspension Systems," pages 283-301.
   b. Study all schematic drawings thoroughly.
   c. Answer quiz questions 1-35 on pages 300, 301.
   d. Read Chapter 17, "Front Wheel Alignment, Steering System," pages 313-336.
   e. Study all the schematic drawings throughly.
   f. Answer quiz questions 1-17 on page 336.
   g. Return text to shelf and turn quiz answers over to the instructor for evaluation.
2. Do the following assignments using Auto Repair and Service:
   a. Read Chapter 31, "Steering Suspension Systems Service," pages 31.20 through 31.38.
   b. Study all the schematic drawings.
   c. Familiarize yourself with "Problem Diagnosis," pages 31.38 through 31.40.
   d. Complete answers to quiz questions 23-42 on page 31.41.
   e. Read Chapter 30, "Wheels, Bearings, Tires," pages 30.1 through 30.20.

Principal Author(s): J. Anderson/W. Osland

Procedure: continued

f. Study all the schematic drawings on page 30.20.
g. Read the "Problem Diagnosis" section, page 30.26 through page 30.29. This information will be helpful in actual work diagnosing.
h. Answer quiz questions 1-24 on pages 30.29 and 30.30.
i. Return text to shelf and turn your quiz answers over to the instructor for evaluation.

3. Take and score the LAP test.

4. If the score is less than 80%, review the material.

Student: ____________________ File Code: 37.10.04.01.B1-2

Date: ____________________ Date Published: 3/11/76

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LAP TEST: FUNDAMENTALS OF FRONT-END SUSPENSION

1. The integral type frame is constructed as a:

    a.. part of the body.
    b. separate unit from the body.
    c. part of the main suspension.
    d. separate steel frame.

2. Spring oscillation is:

    a. the forward and backward movement of the springs caused by the hitting a bump.
    b. the up and down movement of the spring caused by the wheel hitting a bump.
    c. the upward movement of the spring caused by the wheel hitting a bump.
    d. the downward motion of the spring caused by the wheel hitting a bump.

3. Independent front suspension:

    a. lets each front wheel turn independently.
    b. allows the car to turn freely on corners.
    c. allows either front wheel to move up and down independently.
    d. allows the front wheels to move up and down at the same time.

4. The use of ball joints on the independent front suspension replaces the use of:

    a. rubber bushing and gromets.
    b. spindle and wheel bearings.
    c. springs and shackles.
    d. threaded bushings and kingpins.

5. The stabilizer bar is used to:

    a. stabilize lower control arm.
    b. overcome spring oscillations.
    c. overcome unsprung weight.
    d. overcome the tendency for car's body to lean on corners.

6. When lubricating the suspension system, never grease:

    a. ball joints.
    b. kingpins.
    c. tie rod ends.
    d. rubber gromets and bushings.

37.10.04.01. cont.

7. Positive camber is tipping the tops of the wheels:

   a. in.
   b. out.
   c. back.
   d. forward.

8. When removing coil springs that are under pressure:

   a. lower the complete front-end.
   c. keep the weight on the spring.
   d. use a coil spring compressor.

9. A long bar of strong steel that is used to support suspension weight is referred to as a:

   a. strut bar.
   b. stabilizer bar.
   c. torsion bar.
   d. tie rod bar.

10. The term used for the weight of all parts of the car that are supported by the suspension system is:

   a. drop-weight.
   b. unsprung weight.
   c. out-of-balance.
   d. sprung weight.

LAP TEST ANSWER KEY: FUNDAMENTALS OF FRONT-END SUSPENSION

1. a
2. b
3. [redacted] C
4. [redacted] D
5. d
6. [redacted] D
7. b
8. d
9. [redacted] C
10. [redacted] D

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Learning Activity Package

Student: ____________

Date: ____________

PERFORMANCE ACTIVITY: Replacing Ball Joints

OBJECTIVE:

identify the correct procedure for removing and replacing the ball joints. Replace a set of ball joints.

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after completion of LAP 37,10,04,03.

RESOURCES:

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Automobile needing new ball joints
Jack
Jack stands

Replacements parts
Special tools for installation of ball joints
Tools, Basic Hand: (see Unit LEG)

PROCEDURE:

NOTE: Review pages 31-23 through 31-28 in Auto Service and Repair.

CAUTION: Extreme caution must be observed because of the coil springs.

1. Raise vehicle and secure it safely with jack stands.
2. Remove wheel and assembly.
3. Clean suspension parts and ball joints of dirt and grease to improve working conditions.
4. Obtain manual for the specific directions to follow for the particular make, model and year of the car being worked on.
   NOTE: Due to the variety of suspension systems, the mechanic must learn to use the manual in working independently with each individual automobile.

Principal Author(s): J. Anderson/W. Osland

5. Follow the directions in the manual for changing the ball joints.
6. Return manual, tools and all equipment to their proper places after lowering the car.
7. Be sure new ball joints have a sufficient amount of grease before leaving the shop.
8. Upon completion, the instructor will inspect the job. If satisfactory, proceed to the next LAP.

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Replacement of Tie-Rod Ends

OBJECTIVE:

Demonstrate the correct procedure for replacement of tie-rod ends.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Automobile needing tie-rod replacement
Cotter keys
Grease
Jack
Jack stands
New Tie-Rod Ends
Tools, basic hand (See Unit LEG)

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

PROCEDURE:

NOTE: Review pages 31-21 through 31-22 in Auto Service and Repair.

1. Raise front of vehicle and secure with jack stands.
2. Remove tie-rods. Refer to manual for correct removal procedure.
3. Compare new tie-rod end to the old one to be sure of exact replacement.
4. Install the new tie-rod end following the procedure from the repair manual.
5. Ask the instructor to evaluate your work.
6. Lower vehicle.
7. Clean and return all tools and equipment.
8. Clean work areas.
9. Take and score the LAP test.
10. Upon successful completion, proceed to the next LAP.

Principal Author(s): J. Anderson/W. Osland

Student: ______________________ **File Code:** 37.10.04.02.-.03 B1-2

Date: ______________________ **Date Published:** 12-6-77

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LAP TEST: REPLACEMENT OF BALL JOINTS AND TIE-ROD-ENDS

37.10.04.02

1. Often the factory installed joints (original equipment):

    a. are riveted into place and must be cut.
    b. are pressed into place and must be cut out.
    c. can only be replaced by replacing the entire control arm assembly.
    d. must be cut out entirely with a torch.

2. In replacing a balljoint with the spring on the upper control arm:

    a. the spring must be removed.
    b. the weight of the car must be supported by the upper control arm.
    c. a block or a support wedge should be used between the upper control arm and the frame.
    d. a hydraulic jack must be used to lower the control arm after the ball stud nut is loosened.

3. Riveted mounted ball joints are replaced with:

    a. bolts.
    b. new rivets.
    c. welding into place.
    d. screw in ball joints.

4. Pressed ball joints are removed from the spindle:

    a. with a special tool and a hammer.
    b. with a special tool.
    c. with a hammer.
    d. by the use of heat.

5. After installation of the joint into the spindle:

    a. a lock washer and nut should be quickly installed.
    b. the nut should be hand tightened as much as possible and pinned.
    c. the nut should be torqued.
    d. the joint nut and a lock nut should be installed.

6. After ball joint installation, camber should be checked and adjusted on:

    a. shim adjusting vehicles.
    b. eccentric adjusting vehicles.
    c. all types of suspension systems.
    d. sliding slot adjustment vehicles.

37.10.04.02 (continued)

7. After joint installation:

   a. the new joint should be checked for amount of free play.
   b. the joint should be tested.
   c. the jack should be lowered slowly in releasing the car weight.
   d. the joint should be lubricated.

37.10.04.03

8. After first torquing the tie-rod-end nut to specifications:

   a. install a cotter key and bend the ends down flat.
   b. it is recommended to rap the spindle arm and retorque.
   c. adjust the tie rod sleeve to the correct length.
   d. also tighten the rie rod sleeve locking clamps.

9. The tie-rod-end should be threaded into the sleeve:

   a. at any time convenient.
   b. after installation into the tapered hole.
   c. by turning the sleeve.
   d. before installation into the tapered hole.

10. Toe-in adjustment can be almost unnecessary if the:

   a. the tie rod sleeve is measured before disassembly.
   b. tie rod sleeve is marked.
   c. tie rod length is measured before disassembly.
   d. the wheel and steering wheel are locked in the straight ahead position.

LAP TEST ANSWER KEY: REPLACEMENT OF BALL JOINTS AND TIE-ROD-ENDS

LAP .02

1. A or C
2. C
3. A
4. A or B
5. C
6. All
7. D

LAP .03

8. B or A
9. D
10. C

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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Replacement of Idler Arms

OBJECTIVE:

Recognize the correct procedure for the removal and replacement of idler arms.

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after completion of LAP 37.10.04.05.

RESOURCES:

Automobile needing idler arm replacement
Cotter key
Creeper
Idler arm
Jack
Jack stands
Tools, Basic Hand: (See Unit LEG)

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

PROCEDURE:

NOTE: Review page 31-22 in Auto Service and Repair.

1. Raise vehicle and secure stands.
2. Remove defective idler arm. Refer to repair manual for procedure.
3. Compare defective idler arm to the new idler arm to insure exact replacement.
4. Install new idler arm and cotter key.
5. Ask the instructor to evaluate your completed work.
6. Clean and return all tools and equipment.
7. Clean work area.
8. Proceed to next LAP.

Principal Author(s): J. Anderson/W. Osland

File Code: 37.10.04.05.B1-0

Date Published: 3/10/76

Mountain-Plains Education & Economic Development Program, Inc.
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Learning Activity Package

Student: ____________

Date: ____________

PERFORMANCE ACTIVITY: Replacement of Control Arm Bushings

OBJECTIVE:

Demonstrate correct procedure for replacement of control arm bushings.

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Automobile needing control arm bushing replacement
Jack
Jack stand
New control arm bushings
Tools, Basic Hand: (See Unit LEG)

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

PROCEDURE:

NOTE: Review page 31-30 through 31-31 in Auto Service and Repair.

1. Raise front of vehicle and secure jack stands.
2. Remove front wheels for easier access to bushings.
3. Locate removal procedure in manual and follow the procedure step-by-step to safely and properly remove and replace the control arm bushings.
   NOTE: Because of the variety of vehicles and safety precautions, it is mandatory to refer to a repair manual.
4. Ask the instructor to evaluate your work.
5. Lower car.
6. Clean and return all tools and equipment to tool room.
7. Clean work area.
8. Take and score the LAP test.

Principal Author(s): J. Anderson/W. Osland

9. Upon completion of LAP test obtain a copy of unit post test. Answer all of the questions and return test to the instructor for evaluation.
10. Upon successful completion of unit test, proceed to the next unit.

Student: ____________________ File Code: 37.10.04.04 & .05 B1-2

Date: ____________________ Date Published: 3-10-76

Revised: 8-07-78

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LAP TEST: REPLACEMENT OF IDLER ARMS AND CONTROL ARM BUSHINGS

37.10.04.04

1. The function of the idler arm is to:

   a. support front-end suspension weight.
   b. move the steering linkage to turn the wheels.
   c. carry the steering linkage movement.
   d. move the pitman arm in the direction necessary to turn.

2. The idler arm is bolted to:

   a. the frame and linkage.
   b. the frame and the pitman arm.
   c. the pitman and the linkage.
   d. the tie rod and tie rod center link.

3. Idler arm replacement can be done with:

   a. pickle fork, hand tools, hammer.
   b. hand tools, hammer.
   c. hand tools, press, hammer.
   d. hand tools, hydraulic hand jack.

4. For easier installation of idler arm repair kit components, a:

   a. rubber lubricant can be used on the sliding bushings.
   b. light coat of oil can be used on the sliding bushings.
   c. light coat of heavy grease can be used on the sliding bushings.
   d. application of clean solvent can be used.

5. As part of the installation, idler arms should be:

   a. aligned.
   b. oiled.
   c. adjusted.
   d. torqued.

37.10.04.05

6. If an upper control arm bushing is worn:

   a. replace only the worn bushing.
   b. replace both bushings.
   c. replace upper and lower arm bushings.
   d. it is necessary to replace the entire control arm assembly.

37.10.04.05 (continued)

7. While pressing the new bushings in the control arm pad to prevent collapsing the control arm around the bushing, it is recommended to use:

   a. extreme caution.
   b. a tube support.
   c. a press ram.
   d. a spacer block.

8. To install bushings into a double arm bushing control arm with a press, it is necessary to use what to prevent distortion?

   a. spacer block.
   b. stiffener plate.
   c. tube.
   d. puller.

9. In removing the control arm from the coil spring mounted type, it is mandatory to use:

   a. a hydraulic floor jack.
   b. a coil spring compressor.
   c. a safety chain.
   d. a jack stand on the control arm.

10. On a control arm bushing, the movement of the arm (up and down) is accomplished by:

   a. the bushing outer sleeve rotating in the arm.
   b. the bushing inner part rotating on the bolt.
   c. the twisting of the rubber.
   d. the pivot bolt rotating in the control arm.

LAP TEST ANSWER KEY: REPLACEMENT OF IDLER ARMS AND CONTROL ARM BUSHINGS

LAP 04

1. C

2. A

3. A 4/20

4. A

5. D

LAP 05

6. B

7. D

8. B

9. B

10. C 9/13 K.S.

Student: ______________________ File Code: 37.10.04.00.C1-2

Date: ______________________ Date Published: 11-16-79

Family Education Program

UNIT POST TEST: FUNDAMENTALS OF SUSPENSION (A)

37.10.04.01

1. The integral type frame is constructed as a:

   a. part of the body.
   b. separate unit from the body.
   c. part of the main suspension.
   d. separate steel frame.

2. Spring oscillation is:

   a. the forward and backward movement of the springs caused by the wheel hitting a bump.
   b. the up and down movement of the spring caused by the wheel hitting a bump.
   c. the upward movement of the spring caused by the wheel hitting a bump.
   d. the downward motion of the spring caused by the wheel hitting a bump.

3. The purpose of the shock absorber is to:

   a. eliminate swaying of the car.
   b. keep the tires from bouncing.
   c. fasten the body to the axles.
   d. overcome spring oscillations.

4. Independent front suspension:

   a. lets each front wheel turn independently.
   b. allows the car to turn freely on corners.
   c. allows either front wheel to move up and down independently.
   d. allows the front wheels to move up and down at the same time.

5. When lubricating the suspension system, never grease:

   a. ball joints.
   b. kingpins.
   c. tie rod ends.
   d. rubber gromets and bushings.

6. Caster angle, as applied to the steering system, is the:

   a. amount each tire points in at the front.
   b. inward and outward tilt of the kingpin or ball joint at the top.
   c. forward or backward tilt of kingpin or ball joint at the top.
   d. amount each tire points out at the front.

37.10.04.01 (continued)

7. Positive camber is tipping the tops of the wheels:

   a. in.
   b. out.
   c. back.
   d. forward.

8. When removing coil springs that are under pressure:

   a. lower the complete front-end.
   b. stand clear as the last bolt is loosened.
   c. keep the weight on the spring.
   d. use a coil spring compressor.

9. The term used for the weight of all parts of the car that are supported by the suspension system is:

   a. drop-weight.
   b. unsprung weight.
   c. out-of-balance.
   d. sprung weight.

10. The disadvantage of solid axle front-ends is:

   a. difficulty in aligning the front-ends.
   b. costly front-end repairs.
   c. bump action of the road will effect the other wheel.
   d. leaf springs will sag under excessive weight.

37.10.04.02

11. To test a ball joint with the spring against the upper control arm, the mechanic would need a:

   a. support wedge.
   b. smaller jack.
   c. spring compressor.
   d. ball joint wrench.

12. When replacing a ball joint with the spring on the lower control arm and the ball joint stud loose in the knuckle:

   a. place a safety stand under the lower control arm.
   b. chain up the upper control arm.
   c. remove the coil spring with a spring compressor.
   d. lower the lower control arm carefully with a hydraulic jack.

13. Which of the following statements is true about a McPherson strut front suspension:

   a. upper and lower control arms are used.
   b. two ball joints are used.
   c. camber and caster is adjusted by shimming the upper control arm.
   d. the shock absorber is built into the strut.

37.10.04.02 (continued)

14. When lowering the disconnected ball joint arm with a jack, the jack should be:

   a. a quick release hydraulic hand jack.
   b. parallel with the frame.
   c. directly below the spring on the arm.
   d. parallel with the length of the suspension arm.

15. After installation of the joint into the spindle:

   a. a lock washer and nut should be quickly installed.
   b. the nut should be hand tightened as much as possible and pinned.
   c. the nut should be torqued.
   d. the joint nut and a lock nut should be installed.

37.10.04.03

16. Before tie-rod-end removal:

   a. the tie rod should be checked for being bent.
   b. the length of the tie rod should be measured and recorded.
   c. the tie-rod-end should be threaded out of the sleeve.
   d. the steering wheel should be locked into position.

37.10.04.04

17. After installation, idler arms should be:

   a. aligned.
   b. greased.
   c. adjusted.
   d. torqued.

18. Idler arm movement for wear testing can be done by:

   a. telescoping gauge.
   b. use of a dial indicator.
   c. eye observation.
   d. torque wrench.

37.10.04.05

19. To install bushings into a double arm bushing control arm with a press, it is necessary to use what to prevent distortion?

   a. spacer block.
   b. stiffener plate.
   c. tube.
   d. puller.

20. When replacing suspension arm bushings:

   a. replace the one needed.
   b. always replace both bushings.
   c. replace them with cast iron bushings.
   d. replace upper and lower bushings.

POST TEST ANSWER KEY: FUNDAMENTALS OF SUSPENSION (A)

LAP .01

1. A
2. B
3. D
4. C
5. D
6. C
7. B
8. D
9. D
10. C

LAP .02

11. A
12. D
13. D
14. D
15. C

LAP .03

16. B

LAP .04

17. D
18. C

LAP .05

19. B
20. B

Student: ______________________ File Code: 37.10.04.00.C1-2(B)

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Mountain-Plains Education &
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Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: FUNDAMENTALS OF SUSPENSION (B)

37.10.04.01

1. The disadvantage of solid axle front-ends is:

   a. difficulty in aligning the front-end.
   b. costly front-end repairs.
   c. bump action of the road will effect the other wheel.
   d. leaf springs will sag under excessive weight.

2. The term used for the weight of all parts of the car that are supported by the suspension system is:

   a. drop-weight.
   b. unsprung weight.
   c. out-of-balance.
   d. sprung weight.

3. When removing coil springs that are under pressure:

   a. lower the complete front-end.
   b. stand clear as the last bolt is loosened.
   c. keep the weight on the spring.
   d. use a coil spring compressor.

4. Positive camber is tipping the tops of the wheels:

   a. in.
   b. out.
   c. back.
   d. forward.

5. Caster angle, as applied to the steering system, is the:

   a. amount each tire points in at the front.
   b. inward and outward tilt of the kingpin or ball joint at the top.
   c. forward or backward tilt of kingpin or ball joint at the top.
   d. amount each tire points out at the front.

6. When lubricating the suspension system, never grease:

   a. ball joints.
   b. kingpins.
   c. tie rod ends.
   d. rubber gromets and bushings.

37.10.04.01 (continued)

7. Independent front suspension:

   a. lets each front wheel turn independently.
   b. allows the car to turn freely on corners.
   c. allows either front wheel to move up and down independently.
   d. allows the front wheels to move up and down at the same time.

8. The purpose of the shock absorber is to:

   a. eliminate swaying of the car.
   b. keep the tires from bouncing.
   c. fasten the body to the axles.
   d. overcome spring oscillations.

9. Spring oscillation is:

   a. the forward and backward movement of the springs caused by the wheel hitting a bump.
   b. the up and down movement of the spring caused by the wheel hitting a bump.
   c. the upward movement of the spring caused by the wheel hitting a bump.
   d. the downward motion of the spring caused by the wheel hitting a bump.

10. The integral type frame is constructed as a:

   a. part of the body.
   b. separate unit from the body.
   c. part of the main suspension.
   d. separate steel frame.

37.10.04.02

11. After installation of the joint into the spindle:

   a. a lock washer and nut should be quickly installed.
   b. the nut should be hand-tightened as much as possible and pinned.
   c. the nut should be torqued.
   d. the joint nut and a lock nut should be installed.

12. When lowering the disconnected ball joint arm with a jack, the jack should be:

   a. a quick release hydraulic hand jack.
   b. parallel with the frame.
   c. directly below the spring on the arm.
   d. parallel with the length of the suspension arm.

13. When replacing a ball joint with the spring on the lower control arm and the ball joint stud loose in the knuckle:

   a. place a safety stand under the lower control arm.
   b. chain up the upper control arm.
   c. remove the coil spring with a spring compressor.
   d. lower the lower control arm carefully with a hydraulic jack.

37.10.04.02 (continued)

14. Which of the following statements is true about a McPherson strut front suspension?

   a. upper and lower control arms are used.
   b. two ball joints are used.
   c. camber and caster is adjusted by shimming the upper control arm.
   d. the shock absorber is built into the strut.

15. To test a ball joint with the spring against the upper control arm, the mechanic would need a:

   a. support wedge.
   b. smaller jack.
   c. spring compressor.
   d. ball joint wrench.

37.10.04.03

16. Before tie-rod-end removal:

   a. the tie rod should be checked for being bent.
   b. the length of the tie rod should be measured and recorded.
   c. the tie-rod-end should be threaded out of the sleeve.
   d. the steering wheel should be locked into position.

37.10.04.04

17. Idler arm movement for wear testing can be done by:

   a. telescoping gauge.
   b. use of a dial indicator.
   c. eye observation.
   d. torque wrench.

18. After installation, idler arms should be:

   a. aligned.
   b. greased.
   c. adjusted.
   d. torqued.

37.10.04.05

19. When replacing suspension arm bushings:

   a. replace the one needed.
   b. always replace both bushings.
   c. replace them with case iron bushings.
   d. replace upper and lower bushings.

20. To install bushings into a double arm bushing control arm with a press, it is necessary to use what to prevent distortion:

   a. spacer block.
   b. stiffener plate.
   c. tube.
   d puller

UNIT POST TEST: FUNDAMENTALS OF SUSPENSION

LAP .01

1. C
2. D
3. D
4. B
5. C
6. D
7. C
8. D
9. B
10. A

LAP .02

11. C
12. D
13. D
14. D
15. A

LAP .03

16. B

LAP .04

17. C
18. D

LAP .05

19. B
20. B

Mountain-Plains Education &
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Student: ______________________ File Code: 37.10.04.00.C1-2C

Date: ______________________ Date Published: 11-7-77

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UNIT POST TEST: FUNDAMENTALS OF SUSPENSION (C)

37.10.04.01

1. The integral type frame is constructed as a:

   a. part of the body.
   b. separate unit from the body.
   c. part of the main suspension.
   d. separate steel frame.

2. The disadvantage of solid axle front-ends is:

   a. difficulty in aligning the front-end.
   b. costly front-end repairs.
   c. bump action of the road will offect the other wheel.
   d. leaf springs will sag under excessive weight.

3. When removing coil springs that are under pressure:

   a. lower the complete front-end.
   b. stand clear as the last bolt is loosened.
   c. keep the weight on the spring.
   d. use a coil spring compressor.

4. Caster angle, as applied to the steering system, is the:

   a. amount each tire points in at the front.
   b. inward and outward tilt of the kingpin or ball joint at the top.
   c. forward or backward tilt of kingpin or ball joint at the top.
   d. amount each tire points out at the front.

5. The purpose of the shock absorber is to:

   a. eliminate swaying of the car.
   b. keep the tires from bouncing.
   c. fasten the body to the axles.
   d. overcome spring oscillations.

6. The term used for the weight of all parts of the car that are supported by the suspension system is:

   a. drop-weight.
   b. unsprung weight.
   c. out-of-balance.
   d. sprung weight.

37.10.04.01 (continued)

7. When lubricating the suspension system, never grease:

   a. ball joints.
   b. kingpins.
   c. tie rod ends.
   d. rubber gromets and bushing.

8. Positive camber is tipping the tops of the wheels:

   a. in.
   b. out.
   c. back.
   d. forward.

9. Spring oscillation is:

   a. the forward and backward movement of the springs caused by the wheel hitting a bump.
   b. the up and down movement of the spring caused by the wheel hitting a bump.
   c. the upward movement of the spring caused by the wheel hitting a bump.
   d. the downward motion of the spring caused by the wheel hitting a bump.

10. Independent front suspension:

    a. lets each front wheel turn independently.
    b. allows the car to turn freely on corners.
    c. allows either front wheel to move up and down independently.
    d. allows the front wheels to move up and down at the same time.

37.10.04.02

11. To test a ball joint with the spring against the upper control arm, the mechanic would need a:

    a. support wedge.
    b. smaller jack.
    c. spring compressor.
    d. ball joint wrench.

12. After installation of the joint into the spindle:

    a. a lock washer and nut should be quickly installed.
    b. the nut should be hand tightened as much as possible and pinned.
    c. the nut should be torqued.
    d. the joint nut and a lock nut should be installed.

13. When lowering the disconnected ball joint arm with a jack, the jack should be:

    a. a quick release hydraulic hand jack.
    b. parallel with the frame.
    c. directly below the spring on the arm.
    d. parallel with the length of the suspension arm.

37.10.04.02 (continued)

14. When replacing a ball joint with the spring on the lower control arm and the ball joint stud loose in the knuckle:

    a. place a safety stand under the lower control arm.
    b. chain up the upper control arm.
    c. remove the coil spring with a spring compressor.
    d. lower the lower control arm carefully with a hydraulic jack.

15. Which of the following statements is true about a McPherson strut front suspension?

    a. upper and lower control arms are used.
    b. two ball joints are used.
    c. camber and caster is adjusted by shimming the upper control arm.
    d. the shock absorber is built into the strut.

37.10.04.03

16. Before tie-rod-end removal:

    a. the tie rod should be checked for being bent.
    b. the length of the tie rod should be measured and recorded.
    c. the tie-rod-end should be threaded out of the sleeve.
    d. the steering wheel should be locked into position.

37.10.04.04

17. After installation, idler arms should be:

    a. aligned.
    b. greased.
    c. adjusted.
    d. torqued.

18. Idler arm movement for wear testing can be done by:

    a. telescoping gauge.
    b. use of a dial indicator.
    c. eye observation.
    d. torque wrench.

37.10.04.05

19. To install bushings into a double arm bushing control arm with a press, it is necessary to use what to prevent distortion?

    a. spacer block.
    b. stiffener plate.
    c. tube.
    d. puller.

20. When replacing suspension arm bushings:

    a. replace the one needed.
    b. always replace both bushings.
    c. replace them with cast iron bushings.
    d. replace upper and lower bushings.

UNIT POST TEST ANSWER KEY: FUNDAMENTALS OF SUSPENSION (C)

LAP .01

1. A
2. C
3. D
4. C
5. D
6. D
7. D
8. B
9. B
10. C

LAP .02

11. A
12. C
13. D
14. D
15. D

LAP .03

16. B

LAP .04

17. D
18. C
19. B
20. B

Student: ______________________ File Code: 37.10.04.00.B1-5

Date: ______________________ Date Published: 3/10/76

Mountain-Plains Education &
Economic Development
Program, Inc.
Glasgow AFB, Montana 59231

Family Pay Number: __________ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: FRONT-END REPAIR

OBJECTIVE 1:

Inspect all front end parts as per checklist.

OBJECTIVE 2:

Repair front end parts as per checklist.

TASK:

The student will be assigned a vehicle needing front end repair. He will inspect ball joints, tie rod ends, idler arm, pitman arm, connecting link, control arm bushings, and stabilizer bushings for wear. He will replace those parts worn beyond specifications.

ASSIGNMENT:

CONDITIONS:

The student will use only those materials provided for the test and perform the activity in the auto shop.

RESOURCES:

Car needing repairs
New parts as needed.
Jacks
Fender covers
Alignment Tables
Alignment gauge
Chalk
Tire pressure gauge
Pickle Fork
Air Chisel
Lug Wrench
Jack Stands
Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: ______________________ File Code: 37.10.04.00.B1-5

Date: ______________________ Date Published: 3/10/76

Mountain-Plains Education &
Economic Development
Program, Inc.
Glasgow AFB, Montana 59231

Family Pay Number: ________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION Met	CRITERION Not Met
Objective 1:		
1. Inspect ball joints.		
Criterion: Compares to manufacturer's specifications.		
2. Inspect idler arm.		
Criterion: Compares to manufacturer's specifications.		
3. Inspect center link.		
Criterion: Compares to manufacturer's specifications.		
4. Inspect tie rod ends.		
Criterion: Compares to manufacturer's specifications.		
5. Inspect Pitman arm.		
Criterion: Compares to manufacturer's specifications.		
6. Inspect control arm bushings.		
Criterion: Compares to manufacturer's specifications.		
7. Inspect stabilizer bar bushings.		
Criterion: Compares to manufacturer's specifications.		

(Checklist continued)

	CRITERION	
	Met	Not Met
Objective 2:		
8. Repair ball joints.		
Criterion: Must meet manufacturer's specifications.		
9. Repairs idler arm.		
Criterion: Must meet manufacturer's specifications.		
10. Repairs center link.		
Criterion: Must meet manufacturer's specifications.		
11. Repairs tie rod ends.		
Criterion: Must meet manufacturer's specifications.		
12. Repairs Pitman arm.		
Criterion: Must meet manufacturer's specifications.		
13. Repairs control arm bushings.		
Criterion: Must meet manufacturer's specifications.		
14. Repairs stabilizer bar bushings.		
Criterion: Must meet manufacturer's specifications.		
The student must complete 12/14 line items to pass test.		

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Mountain-Plains Education &
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Glasgow AFB, Montana 59231

Learning Experience Guide

UNIT: FRONT-END ALIGNMENT

RATIONALE:

The techniques in this unit will enable one to align front-ends.

PREREQUISITES:

Math at Level F
Communication at Level F

OBJECTIVE:

Recognize the components and use proper procedure for front-end alignment.

RESOURCES:

Printed Materials

Auto Service and Repair. Martin W. Stockel, Goodheart-Willcox Company, Inc.
Motor's Auto Repair Manual. Motor, The Hearst Corporation. 1972 or equivalent.
Operator's Manual for Alignment Equipment.

Audio/Visuals

Super 8 Sound Films: Wheel Alignment

DCA Educational Products, Inc.

Adjusting Torsion Bar Suspension (#FAA142).
Caster Camber Adjustment, Cam Assembly (#FAA102).
Caster Camber Adjustment, Shim (#FAA112).
Caster Camber Adjustment, Slide (#FAA122).
Checking Camber (#FAA072).
Checking Toe and Centering Steering (#FAA092).
Set Up and Suspension Checks (#FAA062).
Toe and Center Steering Adjustments (#FAA132).

Equipment

Alignment equipment
Automobile needing: toe adjustment
shim type wheel alignment
slide type adjustment
eccentric type adjustment
eccentric and strut adjustment
Fender covers
Jack & jack stands

Principal Author(s): C. Schramm/W. Osland

Resources: Equipment Continued

Scribe
Special tools
Tools, Basic Hand:

- Chisel and Punch Set
  - 5/32" Pin Punch
  - 3/16" Solid

- Gauge, feeler (.002" - .025")

- Hammer, ball peen
- Hammer, plastic tip
- Handle, speed
- Hex Key Set

- Pliers, diagonal cutting
- Pliers, needle nose

- Scraper, gasket
- Screwdriver, standard (Set)
- Screwdriver, phillips (Set)
- Screw starter

- Socket Set (3/8" drive)
  - extension (3")
  - ratchet

- Socket Set (1/4" drive)
  - extension (3")
  - handle (6" flex)
  - ratchet

- Socket, spark plug
  - extension (6")

- Wrench, combination (Set)
- Wrench, combination ignition (Set)

Tire pressure guage

GENERAL INSTRUCTIONS:

This unit consists of six Learning Activity Packages (LAPs). Each LAP will provide specific information for completion of a learning activity.

The general procedure for this unit is as follows:

(1) Read the first assigned Learning Activity Package (LAP).
(2) Begin and complete the first assigned LAP.
(3) Take and score the LAP test.
(4) Turn in the LAP test answer sheet.
(5) Determine the reason for any missed items on the LAP test.
(6) Proceed to and complete the next assigned LAP in the unit.
(7) Complete all required LAPs for the unit by following steps 3 through 6.

(8) In this Unit, there are some LAPs that have tests combined with other LAP tests. These combined tests are taken after completing the last LAP covered by the test.
(9) Take the unit tests as described in the Unit LEG "Evaluation Procedures".
(10) Proceed to the next assigned unit.

PERFORMANCE ACTIVITIES:

.01 Adjusting Camber
.02 Adjusting Caster
.03 Adjusting Toe-In
.04 Adjusting Caster-Camber (eccentric and strut)
.05 Adjusting Caster-Camber (eccentric)
.06 Adjusting Caster-Camber (slide)

EVALUATION PROCEDURE:

When pretesting:

1. The student takes the unit multiple-choice pretest.
2. Successful completion is 4 out of 5 items for each LAP part of the pretest.
3. The student then takes a unit performance test if the unit pretest was successfully completed.
4. Satisfactory completion of the performance test is meeting the criteria listed on the performance test.

When post testing:

1. The student takes a multiple-choice unit post test and a unit performance test.
2. Successful unit completion is meeting the listed criteria for the performance test.

FOLLOW-THROUGH:

Go to the first assigned Learning Activity Package (LAP) listed on your Student Progress Record (SPR).

Student: ______________________ **File Code:** 37.10.05.00.B1-2

Date: ______________________ **Date Published:** 3/12/76

Mountain-Plains Education &
Economic Development
Program, Inc.
Glasgow AFB, Montana 59231

UNIT PRETEST: FRONT-END ALIGNMENT

37.10.05.01.

1. After shims are reshuffled and the bolts are tightened:

   a. the car must be bounced and camber reread.
   b. the caster must be adjusted.
   c. the toe-in must be checked.
   d. the camber must be reread.

2. Loose wheel bearings will least affect which alignment reading?

   a. caster.
   b. riding height.
   c. camber.
   d. toe-in.

3. Negative camber is increased by moving the top of the wheel towards the:

   a. engine.
   b. fender opening.
   c. headlight.
   d. taillight.

4.

37.10.05.02.

5. The vehicle manufacturer who has utilized caster-shim adjustment is:

   a. American Motors.
   b. Ford Motors Company.
   c. General Motors.
   d. Chrysler Corporation.

6. What holds the installed shim in place?

   a. the placement groove on the suspension.
   b. the slotted ends of the shims.
   c. the tightened bolt.
   d. the threaded wire through the shims.

37.10.05.02.

7. The removed shims after the alignment should be:

   a. cleaned and refiled.
   b. discarded in the trash.
   c. discarded in the scrap metal storage.
   d. returned to the car owner.

37.10.05.03.

8. Standard tires have the toe reading usually set at:

   a. 1/8 to 1/4 toe-in.
   b. 0 toe-in.
   c. 0 to 1/16 toe-in.
   d. 1/8 to 1/4 toe-out.

9. Radial tires have the toe reading usually set at:

   a. 0 toe-in.
   b. 1/16 to 1/8 toe-in.
   c. 1/16 toe-out
   d. 1/8 toe-in.

10. Toe-in adjustment is accomplished by:

   a. adjusting the pitman arm.
   b. turning one of the tie rod sleeves.
   c. adjusting the steering knuckle.
   d. changing the idler arm angle.

11. The adjusting tie rod sleeve tool is effective for turning the sleeve because it:

   a. is the only tool that can be used to turn the sleeve.
   b. easily fits the sleeve.
   c. is compact and fits into close working quarters.
   d. spreads the sleeve as it grips it for turning.

12. Toe-in of the tires is desired over no toe-in because of the:

   a. resistance of the tires to roll.
   b. crown of the highway.
   c. vehicle's weight.
   d. vehicle's speed capability.

37.10.05.04.

13. The eccentric strut rod adjustment is usually considered the:

   a. same as the others for ease of adjustment.
   b. most difficult of the front-end adjustments.
   c. easiest method of the front-end adjustments.
   d. most time-consuming of all of the adjustments.

37.10.05.04. cont.

14. Adjustment of the strut rod with one hand tool would be a(n):
    - a. box-end wrench.
    - b. open-end wrench.
    - c. deep socket.
    - d. vehicle overload.

37.10.05.05.

15. The eccentric adjuster is shaped somewhat:
    - a. like a wedge.
    - b. oval.
    - c. octagonally.
    - d. like a cam lobe.

16. What must sometimes be done to turn a difficult eccentric?
    - a. raise the wheel of the vehicle.
    - b. heat the eccentric.
    - c. use a power impact wrench.
    - d. hammer the eccentric head.

17. Eccentrics are held in place after alignment by:
    - a. torqued lock bolts.
    - b. new lock bolts.
    - c. cotter keyed bolts.
    - d. pinned eccentrics.

37.10.05.06.

18. The slide adjustment type is usually found more often on the:
    - a. Ford Motor cars.
    - b. General Motors cars.
    - c. American Motors cars.
    - d. Chrysler Corporation cars.

19. By moving the front slide in and the back slide out, you achieve more:
    - a. negative camber.
    - b. positive camber.
    - c. positive caster.
    - d. negative caster.

20. By moving the front slide out and the back slide in, you achieve more:
    - a. positive camber.
    - b. negative camber.
    - c. negative caster.
    - d. positive caster.

UNIT PRETEST ANSWER KEY: FRONT-END ALIGNMENT

LAP .01

1. a
2. a
3. a
4. a

LAP .02

5. c
6. c
7. a

LAP .03

8. a
9. a
10. b
11. d
12. a

LAP .04

13. c
14. b

LAP .05

15. d
16. a
17. a

LAP .06

18. a
19. d
20. d

File Code: 37.10.05.01.B1-0

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Mountain-Plains Education &
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Learning Activity Package

Student: ________________

Date: ________________

PERFORMANCE ACTIVITY: Adjusting Camber (Shim)

OBJECTIVE:

Use correct procedure for adjustment of camber (shim type).

EVALUATION PROCEDURE:

90% correct on performance evaluation.
LAP test after completing LAP 37.10.05.02.

RESOURCES:

Auto Service and Repair, Stockel.
Operator's Manual for Alignment Equipment.

Filmstrips:
- Caster Camber Adjustments,(Shim)--FAA112.
- Checking Camber--FAA072.
- Checking Caster--FAA082.
- Set Up and Suspension Checks--FAA062.

Automobile needing wheels aligned - Shim type
Alignment equipment
Alignment specifications

Fender covers
Tire pressure gauge
Tools, Basic Hand: (See Unit LEG)

PROCEDURE:

NOTE: Review pages 30-26 through 30-29 in Auto Service and Repair.

1. Place vehicle evenly on alignment rack.
2. Diagnose cause of defective wear on tire. Record diagnosis on work order. Record what adjustments would be needed to correct the problem.
   NOTE: Always determine what is the exact cause(s) of the abnormal tire wear. Check for unbalance, improper tire pressure, incorrect camber, incorrect toe-in, poor shocks, worn or damaged suspension components. Be sure to measure the amount of ball joint free-play wear. Also, test and adjust the wheel bearing tightness before continuing further with gauge attachment.
   Record all test and diagnosis on the work order.

Principal Author(s): J. Anderson/W. Osland

3. Discuss your diagnosis with the instructor for evaluation.
4. Check tire inflation of the tires. Correct as necessary.
5. Measure standing height of vehicle to insure vehicle's natural stance. See manual for specifications and procedure of measuring.
6. Carefully attach alignment equipment. Follow set-up procedure of the equipment's operator's manual.
7. Measure the camber and record readings on work order.
8. Compare readings to camber specifications to determine how the adjustment should be made to meet the manufacturer's recommended specifications.
9. Study the shim adjustment of the upper control arm to determine if shims need to be added or subtracted. Refer to the repair manual if a problem occurs in adjustment procedure.
10. Adjust the camber.
11. After the adjustment is completed, ask the instructor to inspect your work for approval.
12. With approval, proceed to the next LAP.

File Code: 37.10.05.02.B1-0

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Learning Activity Package

Student: ______________________

Date: ______________________

PERFORMANCE ACTIVITY: Adjusting Caster (shim)

OBJECTIVE:

Use the correct procedure for adjustment of caster (shim type).

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Alignment equipment
Automobile needing caster adjustment--shim type
Fender covers
Tools, Basic Hand (see Unit LEG)
Operator's Manual for Alignment Equipment.
Motor's Auto Repair Manual.

PROCEDURE:

NOTE: An Alignment Specification Chart comes with the alignment equipment or can be found in Motor's Auto Repair Manaual.

1. Follow the instructions with the alignment equipment and install on the vehicle.
2. Follow the Alignment Specification Chart to obtain the present caster reading of the left wheel. Record results.
3. Compare readings to manufacturer's specifications and analyze how the adjustment should be made without affecting the camber.
4. Make the adjustment.
5. Obtain another reading of the caster to see if the adjustment is satisfactory. Readjust if necessary.
6. Ask the instructor to evaluate your completed adjustment.
7. Repeat the steps to adjust the right wheel. Record present reading before adjustment.
8. Ask the instructor to evaluate the completed adjustments.

Principal Author(s): J. Anderson/W. Osland

9. Clean and return all tools and equipment.
10. Clean work area.
11. Take and score the LAP test.
12. Proceed to the next LAP.

Student: ______________________ File Code: 37.10.05.01.B1-2
37.10.05.02.B1-2

Date: ______________________ Date Published: 11-10-77

Mountain-Plains Education &
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LAP TEST: ADJUSTING CAMBER/CASTER (SHIM)

37.10.05.01

1. To change the camber without affecting the caster, shims:

   a. should be removed or added from the forward bolt.
   b. must be subtracted from one bolt and added to the other bolt.
   c. must be added or subtracted in the same amounts on both bolts.
   d. should be removed or added from the rear bolt.

2. After shims are reshuffled and the bolts are tightened:

   a. the car must be bounced and camber reread.
   b. the caster must be adjusted.
   c. the toe-in must be checked.
   d. the camber must be rereared,

3. Loose wheel bearings will least affect which alignment reading?

   a. caster.
   b. toe-out.
   c. camber.
   d. toe-in.

4. During alignment setup process, which component is not part of front-end check:

   a. "U" joints.
   b. ball joints.
   c. tie-rod-ends.
   d. control arm bushings.

5. Which vehicle manufacturer utilizes the shim's adjustment most?

   a. General Motors.
   b. Ford Motors.
   c. American Motors.
   d. Chrysler Corporation.

37.10.05.02

6. What steering factor is used in the steering suspension system to reduce the need for excessive positive camber?

   a. caster.
   b. toe-in.
   c. steering axis inclination.
   d. toe-out on turns.

7. Positive caster is with the top of the wheel moved in the direction of the:

   a. fender opening.
   b. engine.
   c. taillight.
   d. headlight.

8. To reduce the tendency of the car to wander, you can increase the:

   a. positive camber.
   b. negative camber.
   c. negative caster.
   d. positive caster.

9. The normal weight of the car tends to cause the front wheels to move toward:

   a. negative caster.
   b. negative camber.
   c. positive camber.
   d. positive caster.

10. What holds the installed shims in place?

   a. the placement groove on the suspension.
   b. the slotted ends of the shims.
   c. the tightened bolt.
   d. the threaded wire through the shims.

LAP TEST ANSWER KEY: ADJUSTING CAMBER/CASTER (SHIM)

LAP 01

1. C
2. A
3. A
4. A
5. A

LAP 02

6. C
7. C
8. D
9. B
10. C

File Code: 37.10.05.03.B1-0

Date Published: 3/10/76

Mountain-Plains Education &
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Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Adjusting Toe-In

OBJECTIVE:

Use the correct procedures to adjust toe-in and toe-out.

EVALUATION PROCEDURE:

80% correct on performance evaluation.
Eight correct responses to a ten-item multiple-choice objective test.

RESOURCES:

Automobile needing toe adjustment
Jack
Jack stands
Scribe
Special tools
Tire pressure guage
Tools, basic hand (see Unit LEG)

Auto Service and Repair, Stockel.
Motor's Auto Repair Manual.

Super 8 filmstrips:

Adjusting Torsion Bar Suspension--FAA042.
Checking Toe and Centering Steering--FAA092.
Toe and Center Steering Adjustments--FAA132.

PROCEDURE:

NOTE: Review pages 30-7 through 30-10 in Auto Service and Repair.

NOTE: A. Determine first if the tires are radial or non-radial. Remember: Radial tires are set for zero toe-in unless otherwise specified by either the tire or vehicle manufacturer.

B. Examine and feel the flat surface of the tire to locate a "flathead edge." This feel will indicate if toe-in adjustment is needed, also the direction of needed adjustment.

C. Examine the tread surface for abnormal wear due to incorrect air pressure. Remember:
  1. Low pressure causes extreme wear of the sides of the tire and not in the center.
  2. High pressure causes extreme wear of the center of the tire and not on the sides.

D. Test and adjust tire air pressure as needed to correct wear pattern.

Principal Author(s): J. Anderson/W. Osland

Remember: Record all information and adjustment on the work order in the "comments" section.

1. Raise front tires off floor and place jack stands.
2. With a scribe or thin marker, make a clean line along the tread of the tire. Brace the marker against the tire and turn the tire around to make the complete even line.
3. Repeat this on the other front tire.
4. Refer to the manual to find the recommended toe.
5. With assistance, measure from line to line on the front part of the tire, at an even height from the floor. Record measurement.
6. Now, measure the rear part of the tire. Record measurement.
7. Subtract the front measurement from the rear measurement. The difference should match the recommended toe from the specifications.
8. Adjust if required.
9. Ask the instructor to evaluate your work.
10. Clean and return all tools and equipment.
11. Clean work area.
12. Take and score the LAP test.
13. Upon successful completion, proceed to the next LAP.

Student: ______________________ File Code: 37.10.06.03.B1-2

Date: ______________________ Date Published: 3/10/76

Mountain-Plains Education &
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LAP TEST: ADJUSTING TOE-IN

1. Standard tires have the toe reading usually set at:

   a. 1/8 to 1/4 toe-in.
   b. 0 toe-in.
   c. 0 to 1/16 toe-in.
   d. 1/8 to 1/4 toe-out.

2. Tires with excessive toe-out will have the "feather edge" to:

   a. both sides of the tire.
   b. the tire's inside.
   c. the tire's center.
   d. the tire's outside.

3. Tires which have excessive toe-in will result with the "feather edge" on:

   a. the outside.
   b. the inside.
   c. the tire center.
   d. both sides of the tire.

4. Toe-in adjustment is accomplished by:

   a. adjusting the pitman arm.
   b. turning one of the tie rod sleeves.
   c. adjusting the steering knuckle.
   d. changing the idler arm angle.

5. Before adjusting the toe-in, the what should be centered?

   a. front tires.
   b. right tire.
   c. left tire.
   d. steering wheel.

6. After toe-in is adjusted, the front-end should:

   a. be bounced and measured again.
   b. be measured again.
   c. test driven.
   d. greased.

7. If alignment equipment is not available, what can be used to easily set toe?

   a. tape measure.
   b. yardstick.
   c. string.
   d. a steel rod

8. Setting toe with a measurement tool (not regular alignment equipment) requires measuring from the tire's:

   a. circular scribed lines.
   b. outside edges.
   c. center tread marks.
   d. inside rim edge.

9. Toe measurement and adjustment (to be satisfactory) must be done with:

   a. the vehicle front up on two jack stands.
   b. the vehicle sitting normally on a flat surface.
   c. the vehicle up on four jack stands.
   d. the vehicle jacked up on an alignment rack.

10. Toe-in of the tires is desired over no toe-in because of the:

    a. resistance of the tires to roll straight down the road.
    b. crown of the highway.
    c. vehicle's weight.
    d. vehicle's speed capability.

LAP TEST ANSWER KEY: ADJUSTING TOE

LAP .03

1. a
2. d
3. b
4. b
5. d
6. a
7. a
8. a
9. b
10. a

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File Code: 37.10.05.04.B1-0

Date Published: 3/10/76

Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Adjusting Caster-Camber (eccentric and strut)

OBJECTIVE:

Use the correct procedure for adjustment of caster-camber (eccentric and strut).

EVALUATION PROCEDURE:

80% correct on performance checklist.
Eight correct responses to a ten-item multiple choice objective test.

RESOURCES:

Motor's Auto Repair Manual.

Alignment equipment
Automobile with eccentric and strut adjustment
Fender Covers
Tire pressure guage
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

Steps

1. Center the vehicle properly on the alignment area.
2. Diagnose the tire wear to determine what adjustments are needed. Record results on work order.
3. Check tire pressure. Correct as necessary.
4. Inspect vehicle stand height for uneveness of suspension.
5. Attach and adjust the alignment equipment.
6. Obtain the vehicle's present readings of caster and camber. Record on work order.
7. Obtain the manufacturer's specifications from the manual and record on work order.
8. Place fender covers.

Principal Author(s): J. Anderson/W. Osland

9. Refer to the repair manual for the correct procedure of adjusting the cam and strut-rod to obtain the correct alignment readings.
10. Complete the necessary adjustments to have the vehicle caster and camber meet the manufacturer's specifications.
11. When the adjustments are completed, ask the instructor to evaluate your work.
12. Clean and return all tools and equipment.
13. Clean alignment area.
14. Proceed on to next LAP.

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Date Published: 3/10/76

Mountain-Plains Education &
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Glasgow AFB, Montana 59231

Learning Activity Package

Student: ____________________

Date: ____________________

PERFORMANCE ACTIVITY: Adjusting Caster-Camber (eccentric)

OBJECTIVE:

Use the correct procedure for adjustment of caster-camber (eccentric and strut).

EVALUATION PROCEDURE:

80% correct on performance checklist.
LAP test after the completion of LAP 37.10.05.06.

RESOURCES:

Motor's Auto Repair Manual.

Alignment equipment
Automobile with eccentric and street adjustment
Fender covers
Tire pressure guage
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

Steps

1. Center vehicle on alignment area.
2. Inspect tire wear to determine needed adjustment. Record on work order.
3. Check tire air pressures. Adjust if necessary.
4. Inspect vehicle curb height for proper suspension setting level.
5. Attach and adjust alignment equipment.
6. Obtain and record the present camber and caster readings.
7. Obtain the alignment specifications from the reference manual and record on work order.
8. Refer to the repair manual for the proper procedure of adjusting the eccentric cams.
9. Place fender covers.

Principal Author(s): J. Anderson/W. Osland

10. Complete the caster and camber adjustments as needed to meet the manufacturer's specifications.
    NOTE: The caster and camber are adjusted by the same eccentric cams. Care must be taken not to disturb one adjustment while making the other.
11. When the adjustments are completed, ask the instructor to evaluate your work.
12. Clean and return all tools and equipment.
13. Clean alignment area.
14. Proceed to next LAP.

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File Code: 37.10.05.06.B1-0

Date Published: 3/10/76

Learning Activity Package

Student: ____________

Date: ____________

PERFORMANCE ACTIVITY: Adjusting Caster-Camber (slide)

OBJECTIVE:

Use the correct procedure for adjustment of caster-camber (slide type).

EVALUATION PROCEDURE:

80% correct performance checklist.
LAP test.

RESOURCES:

Operator's Manual for Alignment Equipment.
Motor's Auto Repair Manual.

Filmstrips:

Caster Camber Adjustment, Cam Assembly--FAA102.
Caster Camber Adjustment, Slide--FAA122.

Alignment equipment
Automobile with slide adjustment
Fender covers
Tire pressure guage
Tools, Basic Hand (see Unit LEG)

PROCEDURE:

1. Locate vehicle properly on alignment stall.
2. Examine tire wear to determine adjustments needed.
3. Check tire air pressure. Adjust to correct pressure if necessary.
   NOTE: Determine if abnormal wear is caused by improper tire air pressure, unbalanced tires, poor shocks, incorrect camber or toe-in, worn or damaged suspension components. Record diagnosis on work order.
4. Check curb height of vehicle to be sure of level suspension.
5. Attach and adjust alignment equipment. (Follow the instructions with the alignment equipment.)
6. Obtain alignment specifications from reference manual and record on work order.
7. Obtain the present readings of camber and caster.
8. Place fender covers.

Principal Author(s): J. Anderson/W. Osland

9. Make the necessary adjustments to meet the alignment specifications. Loosen the retaining lock bolt enough to use the slide tool to move the upper control arm to the direction of required adjustment. Tighten bolt to prevent slipping when slide tool is released.

   NOTE: Caster and camber are adjusted by this slide procedure. In some cases, it is necessary to loosen both retaining lock bolts.
10. After adjustments are completed, ask the instructor to evaluate your work.
11. Clean and return all tools and equipment.
12. Clean alignment area.
13. Proceed to next LAP.

Student: ____________________ File Code: 37.10.05.04-.06 B1-2

Date: ____________________ Date Published: 3-10-76

Revised: 8-14-78

Mountain-Plains Education &
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LAP TEST: ADJUSTING CASTER/CAMBER (SLIDE, ECCENTRIC, STRUT)

37.10.05.06

1. By moving both slides out the same amount, you achieve more:

   a. positive caster.
   b. negative caster.
   c. positive camber.
   d. negative camber.

2. By moving the front slide in and the back slide out, you achieve more:

   a. negative camber.
   b. positive camber.
   c. positive caster.
   d. negative caster.

3. In moving the slide adjustment, it is easier to:

   a. loosen bolts enough to move both slides at the same time.
   b. loosen one bolt a little to pivot and loosen the other more to slide.
   c. loosen only the one slide that you intend to move.
   d. loosen one and tap the other with a hammer.

37.10.05.05

4. Camber is adjusted by moving the eccentrics (without affecting caster):

   a. one at a time in opposite directions.
   b. in opposite directions at the same amount.
   c. in the same direction and the same amount.
   d. in the same direction, but move the back 1/3 farther than the other.

5. Before the eccentric can be turned, what must be done?

   a. oil the eccentric slide surface.
   b. loosen the lock bolt.
   c. remove the cotter key.
   d. loosen the lock nut.

6. Eccentrics are held in place after alignment by:

   a. lock nuts.
   b. new lock bolts.
   c. cotter keyed bolts.
   d. pinned eccentrics.

37.10.05.04

7. Of the eccentric and strut adjustment, camber is usually adjusted by:

   a. the eccentric and strut rod.
   b. the strut rod.
   c. the eccentrics.
   d. the slide bolt.

8. Of the eccentric and strut adjustment, caster is usually adjusted by:

   a. the strut rod.
   b. the eccentric.
   c. eccentric and strut rod.
   d. the slide bolt.

9. The eccentric strut rod adjustment is usually considered the:

   a. same as the others for ease of adjustment.
   b. most difficult of the front-end adjustments.
   c. easiest method of the front-end adjustments.
   d. most time-consuming of all the adjustments.

10. Adjusting the caster (strut rod):

   a. has no affect upon camber.
   b. has no affect upon the toe-in.
   c. will change the camber slightly.
   d. will change steering axis inclination.

LAP TEST ANSWER KEY: ADJUSTING CASTER/CAMBER (SLIDE, ECCENTRIC, STRUT)

1. C
2. D
3. B
4. C
5. D
6. A
7. C
8. A
9. C
10. C

Student: ______________________ File Code: 37.10.05.00 C1-2

Date: ______________________ Date Published: 11-22-77

Mountain-Plains Education &
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UNIT POST TEST: FRONT-END ALIGNMENT (A)

37.10.05.01

1. Which of the following is not part of alignment precheck?

   a. air pressure
   b. shocks
   c. trunk weight
   d. riding height

2. The turn tables are not necessary to adjust the:

   a. caster
   b. riding height
   c. camber
   d. toe-in

3. Negative camber is increased by moving the top of the wheel towards the:

   a. engine
   b. fender opening
   c. headlight
   d. taillight

4. Positive camber is increased by moving the tops of the wheel towards the:

   a. engine
   b. headlight
   c. fender opening
   d. taillight

37.10.05.02

5. Negative caster is with the top of the wheel moved in the direction of the:

   a. fender opening
   b. headlight
   c. engine
   d. rear taillight

6. If the specifications call for a difference between the left and right wheel camber settings it would be to compensate for:

   a. engine torque
   b. road resistance
   c. drivers weight
   d. road crown

37.10.05.02 cont.

7. Which of the following is most responsible for steering stability on a level road?

   a. caster
   b. camber
   c. steering axis inclination
   d. toe-out

37.10.05.03

8. Radial tires have the toe reading usually set at:

   a. 0 toe-in
   b. 1/16 to 1/8 toe-in
   c. 1/16 toe-out
   d. 1/8 toe-in

9. Proper toe-in will allow the tires to move forward without:

   a. setting up a wheel tramp
   b. a scrubbing, scraping action between tire and road
   c. going into a wheel shimmy
   d. causing a front-end vibration

10. Toe-in adjustment is accomplished by:

   a. adjusting the pitman arm
   b. turning one of the tie rod sleeves
   c. adjusting the steering knuckle
   d. changing the idler arm angle

11. The adjusting tie rod sleeve tool is effective for turning the sleeve because it:

   a. is the only tool that can be used to turn the sleeve
   b. easily fits the sleeve
   c. is compact and fits into close working quarters
   d. spreads the sleeve as it grips it for turning

12. Setting toe with a measurement tool (not regular alignment equipment) requires measuring from the tire's:

   a. circular scribed lines
   b. outside edges
   c. center tread marks
   d. inside rim edge

37.10.05.04

13. A car may have a tendency to pull to the side having:

   a. more positive caster
   b. less positive caster
   c. less negative caster
   d. less positive camber

37.10.05.04 cont.

14. It is best to start out by adjusting the:

    a. strut rod
    b. camber first
    c. caster-camber together
    d. caster first

15. Strut rod adjustment can vary from each other to allow for:

    a. road crown
    b. road resistance
    c. vehicle weight
    d. vehicle overload

37.10.05.05

16. Which reading can be observed at the same time it is being adjusted?

    a. negative caster
    b. caster
    c. camber
    d. positive caster

17. What must sometimes be done to turn a difficult eccentric?

    a. raise the vehicle off the wheel
    b. heat the eccentric
    c. use a power impact wrench
    d. hammer the eccentric head

37.10.05.06

18. A car has a strut rod from the front of the frame to the lower control arm. Which of the following is true about this system?

    a. shortening the rod changes camber
    b. the length of the rod will not affect caster or camber
    c. the rod acts as a stabilizer bar
    d. lengthening the rod reduces positive caster

19. By moving the front slide in and the back slide out, you achieve more:

    a. positive camber
    b. negative camber
    c. negative caster
    d. positive caster

20. What prevents the slides from moving when the alignment is completed?

    a. cotter pinned slide bolts
    b. torqued down sliding bolts
    c. lock nuts on the slide bolts
    d. the weight of the car

UNIT POST TEST ANSWER KEY: (4)

Lap .01

1. B
2. B
3. A
4. C

Lap .02

5. B
6. D
7. A

Lap .03

8. A
9. B
10. B
11. D
12. A

Lap .04

13. C
14. D
15. A

Lap .05

16. C
17. A

Lap .06

18. D
19. C
20. B

Student: ____________________ File Code: 37.10.05.00.C1-2(B)

Date: ____________________ Date Published: 11/22/77

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UNIT POST TEST: FRONT-END ALIGNMENT (B)

37.10.05.01

1. Positive camber is increased by moving the tops of the wheel towards the:

   a. engine
   b. headlight
   c. fender opening
   d. taillight

2. Negative camber is increased by moving the top of the wheel towards the:

   a. engine
   b. fender opening
   c. headlight
   d. taillight

3. The turn tables are not necessary to adjust the:

   a. caster
   b. riding height
   c. camber
   d. toe-in

4. Which of the following is not part of alignment precheck?

   a. air pressure
   b. shocks
   c. trunk weight
   d. riding height

37.10.05.02

5. Which of the following is most responsible for steering stability on a level road?

   a. caster
   b. camber
   c. steering axis inclination
   d. toe-out

6. If the specifications call for a difference between the left and right wheel camber settings, it would be to compensate for:

   a. engine torque
   b. road resistance
   c. driver's weight
   d. road crown

37.10.05.02 (continued)

7. Negative caster is with the top of the wheel moved in the direction of the:

   a. fender opening
   b. headlight
   c. engine
   d. rear taillight

37.10.05.03

8. Setting toe with a measurement tool (not regular alignment equipment) requires measuring from the tire's:

   a. circular scribed lines
   b. outside edges
   c. center tread marks
   d. inside rim edge

9. The adjusting tie rod sleeve tool is effective for turning the sleeve because it:

   a. is the only tool that can be used to turn the sleeve
   b. easily fits the sleeve
   c. is compact and fits into close working quarters
   d. spreads the sleeve as it grips it for turning

10. Toe-in adjustment is accomplished by:

   a. adjusting the pitman arm
   b. turning one of the tie rod sleeves
   c. adjusting the steering knuckle
   d. changing the idler arm angle

11. Proper toe-in will allow the tires to move forward without:

   a. setting up a wheel tramp
   b. a scrubbing, scraping action between tire and road
   c. going into a wheel shimmy
   d. causing a front-end vibration

12. Radial tires have the toe reading usually set at:

   a. 0 toe-in
   b. 1/16 to 1/8 toe-in
   c. 1/16 toe-out
   d. 1/8 toe-in

37.10.05.04

13. Strut rod adjustment can vary from each other to allow for:

   a. road crown
   b. road resistance
   c. vehicle weight
   d. vehicle overload

37.10.05.04 (continued)

14. It is best to start out by adjusting the:

a. strut rod
b. camber first
c. caster-camber together
d. caster first

15. A Car may have a tendency to pull to the side having:

a. more positive caster
b. less positive caster
c. less negative caster
d. less positive camber

37.10.05.05

16. What must sometimes be done to turn a difficult eccentric?

a. raises the vehicle off the wheel
b. head the eccentric
c. use a power impact wrench
d. hammer the eccentric head

17. Which reading can be observed at the same time it is being adjusted?

a. negative caster
b. caster
c. camber
d. positive caster

37.10.05.06

18. What prevents the slides from moving when the alignment is completed?

a. cotter pinned slide bolts
b. torqued down sliding bolts
c. lock nuts on the slide bolts
d. the weight of the car

19. By moving the front slide in and the back slide out, you achieve more:

a. positive camber
b. negative camber
c. negative caster
d. positive caster

20. A car has a strut rod from the front of the frame to the lower control arm. Which of the following is true about this system?

a. shortening the rod changes camber
b. the length of the rod will not affect caster or camber
c. the rod acts as a stabilizer bar
d. lengthening the rod reduces positive caster

UNIT POST TEST ANSWER KEY: FRONT-END ALIGNMENT (B)

LAP 01

1. c
2. a
3. b
4. b

LAP 02

5. a
6. d
7. b

LAP 03

8. a
9. d
10. b
11. b
12. a

LAP 04

13. a
14. d
15. c

LAP 05

16. a
17. c

LAP 06

18. b
19. c
20. d

Student: ______________________ File Code: 37.10.05.00.C1-2(C)

Date: ______________________ Date Published: 11/22/77

Mountain-Plains Education &
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Program, Inc.
Glasgow AFB, Montana 59231

UNIT POST TEST: FRONT-END ALIGNMENT (C)

37.10.05.01

1. Negative camber is increased by moving the top of the wheel towards the:

   a. engine
   b. fender opening
   c. headlight
   d. taillight

2. Which of the following is not part of alignment precheck?

   a. air pressure
   b. shocks
   c. trunk weight
   d. riding height

3. The turn tables are not necessary to adjust the:

   a. caster
   b. riding height
   c. camber
   d. toe-in

4. Positive camber is increased by moving the tops of the wheel towards the:

   a. engine
   b. headlight
   c. fender opening
   d. taillight

37.10.05.02

5. If the specifications call for a difference between the left and right wheel camber settings, it would be to compensate for:

   a. engine torque
   b. road resistance
   c. driver's weight
   d. road crown

6. Negative caster is with the top of the wheel moved in the direction of the:

   a. fender opening
   b. headlight
   c. engine
   d. rear taillight

37.10.05.02 (continued)

7. Which of the following is most responsible for steering stability on a level road?

   a. caster
   b. camber
   c. steering axis inclination
   d. toe-out

37.10.05.03

8. Radial tires have the toe reading usually set at:

   a. 0 toe-in
   b. 1/16 to 1/8 toe-in
   c. 1/16 toe-out
   d. 1/8 toe-in

9. Setting toe with a measurement tool (not regular alignment equipment) requires measuring from the tire's:

   a. circular scribed lines
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10. The adjusting tie rod sleeve tool is effective for turning the sleeve because it:

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    c. is compact and fits into close working quarters
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11. Proper toe-in will allow the tires to move forward without:

    a. setting up a wheel tramp
    b. a scrubbing, scraping action between tire and road
    c. going into a wheel shimmy
    d. causing a front-end vibration

12. Toe-in adjustment is accomplished by:

    a. adjusting the pitman arm
    b. turning one of the tie rod sleeves
    c. adjusting the steering knuckle
    d. changing the idler arm angle

37.10.05.04

13. It is best to start out by adjusting the:

    a. strut rod
    b. camber first
    c. caster-camber together
    d. caster first

37.10.05.04 (continued)

14. A car may have a tendency to pull to the side having:

    a. more positive caster
    b. less positive caster
    c. less negative caster
    d. less positive camber

15. Strut rod adjustment can vary from each other to allow for:

    a. road crown
    b. road resistance
    c. vehicle weight
    d. vehicle overload

37.10.05.05

16. Which reading can be observed at the same time it is being adjusted?

    a. negative caster
    b. caster
    c. camber
    d. positive caster

17. What must sometimes be done to turn a difficult eccentric?

    a. raise the vehicle off the wheel
    b. heat the eccentric
    c. use a power impact wrench
    d. hammer the eccentric head

37.10.05.06

18. By moving the front slide in and the back slide out, you achieve more:

    a. positive camber
    b. negative camber
    c. negative caster
    d. positive caster

19. What prevents the slides from moving when the alignment is completed:

    a. cotter pinned slide bolts
    b. torqued down sliding bolts
    c. lock nuts on the slide bolts
    d. the weight of the car

20. A car has a strut rod from the front of the frame to the lower control arm. Which of the following is true about this system?

    a. shorening the rod changes camber
    b. the length of the rod will not affect caster or camber
    c. the rod acts as a stabilizer bar
    d. lengthening the rod reduces positive caster

UNIT POST TEST ANSWER KEY: FRONT END ALIGNMENT (C)

LAP 01

1. a
2. b
3. b
4. c

LAP 02

5. d
6. b
7. a

LAP 03

8. a
9. a
10. d
11. b
12. b

LAP 04

13. d
14. c
15. a

LAP 05

16. c
17. a

LAP 06

18. c
19. b
20. d

Student: ____________________ File Code: 37.10.05.00.B1-5

Date: ____________________ Date Published: 3/10/76

Family Pay Number: __________ Sex: M F (Circle 1)

Mountain-Plains Education &
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Glasgow AFB, Montana 59231

UNIT PERFORMANCE TEST: FRONT END ALIGNMENT

OBJECTIVE 1:

Align front end.

TASK:

The student will be assigned a vehicle on which he must align the front end by adjusting camber, caster, and toe.

ASSIGNMENT:

CONDITIONS:

The student will perform the test using only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

Alignment Machine
Special Alignment Wrenches
Service Manual
Parts and Time Guide
Jack
Scribe or Chalk

RESOURCES: (Cont)

Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Mountain-Plains Education &
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Program, Inc.
Glasgow AFB, Montana 59231

Student: ____________________ File Code: 37.10.05.00.B1-5

Date: ____________________ Date Published: 3/10/76

Family Pay Number: __________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

	CRITERION	
	Met	Not Met
Objective 1:		
1. Inspect front end for wear.		
2. Adjust caster.		
3. Adjust camber.		
4. Adjust toe.		
Criterion: Must meet manufacturer's specifications.		
5. Road test.		
Criterion: Must drive straight with no wander or shimmy.		
6. Must perform test in allotted time.		
Criterion: Must meet flat rate for assigned vehicle.		
Student must meet all 6 line items to achieve an overall		
score of satisfactory.		

Student: ____________________ File Code: 37.12.01.00.B1-5

Date: ____________________ Date Published: 3/4/76

Mountain-Plains Education &
Economic Development
Program, Inc.
Glasgow AFB, Montana 59231

Family Pay Number: __________ Sex: M F (Circle 1)

UNIT PERFORMANCE TEST: DETAILING AND SERVICING

OBJECTIVE:

Detail and service a vehicle.

TASK:

The student will be assigned a vehicle on which he must change oil and filter, clean windshield, check water in battery and radiator, check air filter, vacuum interior, check all belts, check power steering fluid, and lubricate door hinges.

ASSIGNMENT:

CONDITIONS:

The student will use only those materials provided for the test and perform the test in the auto shop.

RESOURCES:

Windshield cleaner
Lubrication sticker
Oil
Oil filter
Service manual
Time and parts manual
Oil filter wrench
Drain pan
Fender covers
Jack
Jack stands

RESOURCES: (Continued)

Combination Ignition wrench set
Combination Wrench Set
Standard Screwdriver Set
Phillips Screwdriver Set
Feeler gauge - .002 through .025 inch
Hex Key Set
Diagonal Cutting Pliers
Needle Nose Plier
1/4" Drive Socket Set
Ratchet - 3" and 6" extensions - 6" flex handle
Ball Peen hammer
Plastic Tip Hammer
Screw Starter
Chisel and Punch Set
5/32" Pin Punch - 3/16" Solid
Gasket scraper
3/8" Drive Ratchet
3" Extension
Spark Plug Socket
6" Extension
Speed Handle
3/8" Drive Socket Set

Student: ______________________ **File Code:** 37.12.01.00.B1-5

Date: ______________________ **Date Published:** 3/4/76

Mountain-Plains Education &
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Glasgow AFB, Montana 59231

Family Pay Number: ________ Sex: M F (Circle 1)

PERFORMANCE CHECKLIST:

OVERALL PERFORMANCE: Satisfactory_____ Unsatisfactory_____

CRITERION

	Met	Not Met
Objective:		
1. Change oil and filter.		
Criterion: Read full on dip stick, no leaks on drain plug		
or filter.		
2. Clean windshield and interior.		
Criterion: Be clean for instructor inspection.		
3. Inspect under hood.		
Criterion: Note any problems on work order; have belts		
tight.		
4. Complete test in allotted time.		
Criterion: Complete in one hour.		
Student must satisfactorily complete 3 of 4 line items to		
pass test.		